THE INTEGRITY OF ELECTRIC POWER SYSTEMS

HEARING

BEFORE THE

SUBCOMMITTEE ON
ENERGY DEVELOPMENT AND APPLICATIONS

AND THE

SUBCOMMITTEE ON
ENERGY RESEARCH AND PRODUCTION

OF THE

COMMITTEE ON
SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

NINETY-SEVENTH CONGRESS

SECOND SESSION

DECEMBER 9, 1982

[No. 174]

Printed for the use of the
Committee on Science and Technology

U.S. GOVERNMENT PRINTING OFFICE

18-363 O WASHINGTON : 1983

H701-56

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*On assignment to Budget Committee for 97th Congress

LETTER OF TRANSMITTAL

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, D.C.

To the Members of the Committee on Science and Technology:

There are more than 11,000 electric power generating plants, about 140,000 miles of bulk transmission lines and innumerable distribution systems in the Continental U.S. The Energy Development and Applications Subcommittee and the Energy Research and Production Subcommittee met jointly on 9 December 1982 to receive testimony on the vulnerability of these systems to natural disasters, vandalism, sabotage and the threat of Electro-Magnetic Pulse (EMP), a condition that could disrupt electric power if a nuclear weapon was detonated over the Country at a high altitude. This hearing contains comments from knowledgeable witnesses experienced in policy making for and management of systems for generation and transmission of electricity. Some of the points made by the witnesses were:

1. Vandalism, including the destruction of transmission towers and substations, is significant. Since statistics are not recorded on a national basis, there is no positive way to determine if vandalism is increasing. One utility company had noted a 100 percent increase in 9 years.

2. Organized sabotage has not yet been experienced in the United States as it has in South America, where it is used to demoralize the public by attempting to illustrate the ineffectiveness of the government and to foster anti-government sentiments.

3. The effects of electromagnetic pulse on electric power transmission and distribution systems is not understood. A research program is required. The Department of Energy is initiating such a program in FY 1984.

4. The Department of Energy is analyzing the need for legislation to increase the use of the Electric National Defense Executive Reserve to plan for and respond to severe national power emergencies.

5. The Department of Energy cannot and will not assume responsibility for the utility companies in responding to emergencies. Restoration of electrical power is considered a utility function.

6. Some steps can be taken to lessen the vulnerability of electric power systems, including:

a. Increased security provisions at generating plants;

b. Continued research on superconducting magnetic storage, underground superconducting transmission, photo-conducting electronics, key components, integrated thermionics, materials such as amorphous metal oxide semi-conductors, and fuel cells;

c. Reducing the number of Control Areas (Centers which control the level and distribution of power);

d. Use of underground transmission and distribution where other factors support the expense; and

e. Enhanced communications.

I hope that you will find the information contained in this hearing volume useful.

Sincerely,

DON FUQUA,
Member of Congress.

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THE INTEGRITY OF ELECTRIC POWER SYSTEMS

THURSDAY, DECEMBER 9, 1982

HOUSE OF REPRESENTATIVES, COMMITTEE ON SCIENCE AND TECHNOLOGY, SUBCOMMITTEE ON ENERGY DEVELOPMENT AND APPLICATIONS, SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION,

Washington, D.C.

The subcommittees met, pursuant to call, at 2 p.m., in room 2318, Rayburn House Office Building, Hon. Don Fuqua (chairman of the Subcommittee on Energy Development and Applications) presiding.

Mr. FUQUA. The meeting will come to order.

During the last 100 years, electric power has been brought to virtually every doorstep in the country. It has enhanced the quality of life of every American. The success of the electric power industry and utility companies has been outstanding.

From 1975 through 1979, total energy consumption increased by 12 percent. But from the 1979 peak through 1981, total energy consumption dropped 6 percent. In contrast, electric production has not declined; in fact, it grew from 1975 through 1981 by a total of 20 percent. While electric production growth may have leveled off this year, that can be attributed to a decline in U.S. industrial output and not to a movement away from the use of electricity. With increasing dependence on heat pumps and, possibly, in the future, electric vehicles, our use of electricity can be expected to increase.

Recent criticisms suggest that these electric power systems are not as sturdy as we believed. Furthermore, the critics propose a shift from centralized electric power production to dispersed renewable energy sources. While there is reason to be concerned about the integrity of electric power systems, we must be prudent and cautious in proposing any changes to the system that serves us. New systems will need to be economical and practical for the consumers.

There are many excellent alternative choices for producing energy, but many of these are still site specific, such as geothermal and small-scale hydroelectric power. Power density varies widely among these alternatives, meaning that more power can be generated at a single plant when high density options such as nuclear are used compared to low density options such as solar. Continuity of output that can match load demands, maintenance, and availability requires careful consideration.

Our purpose today is to learn what needs to be done and what options we have available to maintain continuous electric service or, if necessary, to expedite the restoration of service under emergency conditions.

We are particularly interested in the role of the Federal Government in preparing for possible emergencies.

We look forward to today's testimony and to suggestions for more effective Federal policies and programs.

I yield to the gentlelady from Tennessee, Mrs. Bouquard, for a statement.

Mrs. BOUQUARD. Thank you very much, Mr. Chairman.

As you mentioned, our electrical energy systems are a very vital resource. We all seem to think of these systems only on those infrequent occasions when lightning strikes and we are left without lights for an hour or so. But we forget that it is electricity that provides the energy for our water supply, our sewerage systems and things that are so essential for public health. An airplane couldn't land at National Airport in the fog without electricity. Newspapers could not be printed, electronic products could not be manufactured, and certainly food would spoil in packing plants. Our society would not exist as we know it today without the electric power delivery systems that we so often take for granted.

If the integrity of these vital systems is threatened, I want to know about it and I want to know how we can eliminate, or at least minimize, the threat. Of course, all utilities and routes of transportation are threatened by war, and government should have contingency plans ready. However, no one wants to see any change in electric systems that will detract from the outstanding quality of service that has proved to be so reliable over the years. Our quality of life in this century has gone hand-in-hand with electricity growth.

Alternative energy systems should be used to supplement central systems to the extent that they are practical. If a homeowner wants to install a wind machine, he should be encouraged to do this. We should recognize that many homes cannot accommodate alternative systems because of their architecture, size or location. Industry, commerce and transportation certainly have unique requirements. However, in an emergency situation and until primary service can be restored, there may be opportunities for alternative systems, such as fuel cells in the size range of tens of kilowatts to megawatts, to provide interin power in certain areas. I am looking forward this afternoon to getting the facts concerning the integrity of our electric power systems and practical ways to strengthen them.

I want to welcome all of our witnesses, and especially I want to thank Mr. Charles Winn from Chattanooga, from my district, for joining us today.

Thank you, Mr. Chairman.

[The Honorable Tom Harkin of Iowa, although unable to attend this hearing, submitted the following statement for the record:]

PREPARED STATEMENT OF HON. TOM HARKIN OF IOWA

During the past few years, a great deal of debate has taken place and a tremendous amount of money has been spent in an effort to close real or imagined windows of vulnerability in this nation's defense.

All the debate and all the money may not have given sufficient emphasis to a key point.

The sophisticated weapons systems and the sophisticated communications networks we have assembled may very well be useless at the critical moment they are

needed most due to the impact of a single explosion of a small nuclear warhead at a critical point in the upper atmosphere.

In fact, recent reports indicate that the impact of the detonation of a single, small nuclear warhead 250 miles above the city of Omaha, Nebraska would wipe out all communications systems and electrical systems—coast to coast, and border to border—at the speed of light.

The explosion would produce a powerful electromagnetic pulse which would, in the words of some reports, fry every unsheilded electronic and communication circuit in the country.

Now think about that. An unexpected nuclear explosion over Omaha, Nebraska could leave the President at his command post and unable to talk with anyone. He could push his buttons and nothing would happen. Commanders would be unable to communicate with the Commander in Chief, each other, or even their own troops because their communication lines would be disabled. The nation would be literally plunged into darkness. Transportation would grind to a halt as even the ignition systems of automobiles and trucks would be affected.

Surprisingly, very little has been done to guard against this in our vital communication links and our military weapons systems.

It appears, however, that the Soviets have been much more diligent. We all had a good laugh when, in 1976, a pilot landed a Russian Mig-25 in Japan. It was the latest model, the top of the line. And we discovered it was still using vacuum tubes instead of modern up-to-date microchip electronic circuitry.

Well, it wasn't so funny.

We know now that vacuum tubes are a thousandfold less vulnerable to the electromagnetic pulse than the microchip circuitry. They appear to have made great progress in defending themselves against such an attack, but we have hardly begun.

That is but one example * * * certainly a frightening one * * * of the vulnerability of this nation's electric and communications networks in time of crisis and disaster and it is entirely appropriate that this subcommittee take a close look at all of them.

We need not have a nuclear attack to place our electrical system in great danger. Groups of terrorists around the world have been increasingly focusing on power systems. Terrorist attacks have been made against energy facilities in almost forty countries. While most of the attacks have not had a major effect it is clear that our electrical system is becoming increasingly vulnerable.

Attacks are not our only danger. Natural disasters and even errors by the personnel that operate the systems could be disastrous.

As we developed our grid systems to increase our ability to withstand power failures, we may have increased the chances of a major failure that could impact a very large area of the whole country. And, it may become very difficult to start up again once that happens. In 1976, an assistant director of the U.S. Energy Research and Development Administration stated:

"It is becoming apparent that the increasing complexities of the nation's electrical energy systems are rapidly outstripping its capabilities. Our interconnected electric energy systems seem to be evolving into a new condition wherein more is turning out to be different. As they become more tightly interconnected over larger regions, systems problems are emerging which neither are presaged, predicted, or addressed by classical electrical engineering and which are no longer amenable to ad hoc solution."

I believe we need to build our energy infrastructure in ways that will provide resilience. It must have the ability to withstand major damage and continue to function. We have to be able to restart a major electrical grid in a short period of time if we have a major outage or great economic and social problems will occur. In spite of the many claims made, I fear that we do not have that capability now. In September, the GAO found that little progress has been made at improving federal electrical emergency preparedness plans.

For years we were told that a whole grid could not go out of action. Then, we had the New York Blackout in 1965. Twelve years later, on July 10, 1977, the Chairman of Consolidated Edison Company, New York City's electric utility, said that he could guarantee that a recurrence was remote. Three days later, nine million people in New York were blacked out. It took a whole day for some to have their power restored. We have continued to integrate our electrical system so every area of the country is made dependent on other areas. Many believe that if one of the two national grids went down, we would have great difficulty getting it started again.

A number of California utilities have developed some procedures which allow substantial areas to keep their electric power in cases where the electric grid goes down. This is important to those who keep their power on. It may be crucial to the

whole system, since it may enable our electric supply to be reestablished within a short period of time. However, the procedure, called islanding, has not been widely adopted.

We must be asking what can be done to reduce the danger of major electrical failures from all causes. Would a dispersed system of solar and wind facilities improve our ability to withstand disruptions? Do we have critical equipment that cannot be replaced for months or a year if it is destroyed? What new technology is needed to increase the resiliency of our electrical and other energy systems?

Mr. FUQUA. We will start with our panel. After we hear them all, then we will have questions, because I think they may be interrelated and you might want to add or subtract from what other persons have said.

We will start with Mr. William Vaughan, Assistant Secretary for Environmental Protection, Safety and Emergency Preparedness, Department of Energy; followed by Dr. Michael Berger, Deputy Associate Director, Energy Security Programs, Los Alamos; Michael Gent, president, North American Electric Reliability Council; Charles Winn, senior power engineer, TVA; and Robert Iveson, program manager of EPRI, Palo Alto, Calif.

Mr. Vaughan, we will be pleased to hear from you at this time.

STATEMENTS OF WILLIAM A. VAUGHAN, ASSISTANT SECRETARY, ENVIRONMENTAL PROTECTION, SAFETY AND EMERGENCY PREPAREDNESS, U.S. DEPARTMENT OF ENERGY; MICHAEL BERGER, DEPUTY ASSOCIATE DIRECTOR, ENERGY SECURITY PROGRAMS, LOS ALAMOS NATIONAL LABORATORY, LOS ALAMOS, N. MEX.; MICHEHL R. GENT, PRESIDENT, NORTH AMERICAN ELECTRIC RELIABILITY COUNCIL, PRINCETON, N.J.; CHARLES E. WINN, SENIOR POWER ENGINEER, TENNESSEE VALLEY AUTHORITY, CHATTANOOGA, TENN.; AND ROBERT H. IVESON, PROGRAM MANAGER, POWER SYSTEMS PLANNING AND OPERATION, ELECTRIC POWER RESEARCH INSTITUTE, PALO ALTO, CALIF.

Mr. VAUGHAN. Mr. Chairman, Madam Chairman, and members of the two subcommittees, I appreciate the subcommittee's invitation to discuss the integrity of the electric power system. I share your concern with the importance of this topic. As I will discuss, we at DOE believe that we have underway several projects which address these issues in a way which will help assure the viability of the national energy system.

Last May I delivered a statement to the Senate Subcommittee on Energy, Nuclear Proliferation, and Government Processes on the resiliency of the Nation's energy supply systems—in other words, the ability of these systems to recuperate after serious physical disruptions caused by major accidents, natural disasters, sabotage or terrorism.

Today I plan to update that statement by describing some of the recent DOE activities. I will also discuss the Department's role with regard to the integrity of the electric power system.

Based on the studies and reports which have been done in the past, and on recent work done by the Department of Energy in conjunction with other Federal agencies, it is our preliminary view that the Nation's electric power systems, as well as its other major energy systems, have a significant degree of resiliency. However,

the fact cannot be ignored that domestic energy systems could experience unexpected disruptions, including those caused by sabotage. With this in mind, and because energy is so critical to national welfare and security, DOE is presently involved in a project assessing the vulnerability to sabotage and accidents of the electric utility network, natural gas and petroleum pipelines and other parts of the national energy system.

Briefly stated, our objectives are to work in conjunction with the Congress, other Federal and State agencies, other parts of DOE, and appropriate elements in the private sector to:

Identify and develop a technically sound assessment of key energy vulnerabilities;

Develop proposals as needed for reducing these vulnerabilities and report on the state-of-the-art of corrective measures;

Encourage the appropriate organizations to take actions that will reduce the risks and vulnerabilities; and

Prepare to respond appropriately if events occur that are beyond the current level of resiliency of the energy system.

Last June, I sent a letter to 13 Federal departments and agencies informing them of our interest in this subject and requesting comments on the draft program plan. Twenty-two separate responses were received, including twelve from various offices within the armed services and the Defense Department. In general, the responses strongly encouraged the Department to proceed with the suggested program plan and did not reveal any duplication of past or current efforts.

More recently, the White House Office of Science and Technology Policy convened a meeting of officials representing a number of Federal organizations with interest and expertise in various subjects related to energy system vulnerability. This meeting provided an opportunity to share information and ideas on this multifaceted subject. Close coordination with the offices in the Defense Department and the Federal Emergency Management Administration is also taking place.

Most of the effort in this program to date has been concentrated on the electric power system, particularly on the supply of electric power to facilities that are vital to national security. Staff personnel have conducted site visits to a number of critical domestic military bases selected by the Air Force Logistics Command, and have held meetings with the electric utilities serving these bases. These visits were close coordinated with a separate Air Force-sponsored study by the Los Alamos National Laboratory. As you have already observed, Dr. Michael Berger of Los Alamos is also testifying here today.

The detailed case study approach, working directly with local utilities, is consistent with the suggestions made on various occasions by Mr. Michehl Gent and other representatives of the North American Electric Reliability Council.

Of course, it would not be feasible or worthwhile to evaluate all energy supply facilities at this level of detail. However, we are convinced that conducting a few carefully selected case studies offers the surest way to obtain an accurate assessment of the ability of the power systems to respond to major contingencies caused by hostile acts. Although the focus has been on defense facilities, the

analyses also illustrate the potential impacts on other utility customers in the private sector.

We are also looking at other vulnerability issues relating to the strategic petroleum reserve and, in that connection, we have made site visits to the three electric utilities serving key pumping stations of the strategic petroleum reserve.

Draft reports of these case studies are being prepared and should be ready for external technical review early in 1983. However, because they contain sensitive information concerning specific utility installations and operating procedures, as well as some classified military information, the reports themselves will not be available for general public circulation. The key findings will be made available in a form that cannot be used as a blueprint on how to disrupt energy facilities.

Although it would be premature to discuss the results of these case studies before technical views are completed, it has generally been found that a great number of options are available to electric utilities to restore power quickly, particularly to priorty customers that are important to public health and safety or to national security. Furthermore, the extensive interconnections within and among utility systems make an important contribution to this resiliency by providing multiple transmission routes as well as access to a very large number of power sources.

Even when major elements of a system are lost and no spares are available, utility engineers and operators are often quite innovative in rearranging assets of the system to minimize or avoid extensive disruptions of service. These preliminary results appear to contradict recent article statements about the resiliency of the Nation's electric power system.

In addition to the work on electric power vulnerability, a case study on the vulnerability of major petroleum pipelines is being started.

Several other related tasks are also underway to provide general support or to address key issues. For example, our staff is conducting an extensive literature search on many topics related to the vulnerability of energy facilities. This in-house effort will result in a computerized set of titles, abstracts and technical review that will be of continuing use in dealing with this subject. Also in progress is an examination of the availability of critical replacement components, as well as a threat assessment study conducted by DOE's Office of Defense Programs and Sandia National Laboratory covering the capabilities, limitations, and techniques of potential adversaries that might conduct sabotage or terrorist operations against our Nation's energy system.

I do not want to give the impression that I am prejudging the resiliency of the Nation's energy systems against acts of sabotage or other disruptions, or that I have concluded that there are no serious vulnerabilities. The potential definitely exists that the general population and economy might suffer some level of hardship after a major hostile act against an energy system, even if defense facilities are kept operating. We need to know more about the range of possibilities of disruptions occurring and potential levels of hardship which might be experienced due to such disruptions.

Let me reassure you on one more point. We recognize that the owners of energy facilities in the private sector have a strong interest in providing a reliable, resilient and secure energy supply system. This interest in avoiding electric power supply interruptions on the part of the private sector is a vital aspect of any overall security system. In conducting our studies, we in the Department of Energy intend to respect private sector prerogatives and avoid any hint of harassment or suggestion that the Government alone is concerned about security. Without the support and effort by the private sector, energy systems would be much less secure than they are today.

While the Department of Energy routinely monitors emergency situations and stands ready to assist in various ways, if needed, it is certainly not the principal actor at the Federal level. In fact, by law and by current Executive order, the Federal Emergency Management Agency is responsible for coordinating the Federal Government's response to civil emergencies.

If a very serious emergency were to occur involving the Nation's electric power or other energy systems, the appropriate Federal response would depend strongly on the particular facts and circumstances confronting the Nation at the time of the emergency. A recent memorandum of law prepared by the Attorney General and submitted to the Congress summarizes the legal authorities available to the President to respond to severe energy supply interruption.

You can be assured that the Department of Energy and the administration take the question of integrity of the electric power supply system very seriously, and we are vigorously examining the resiliency of this system within the parameters I described.

This concludes my statement. I would be pleased to answer any questions you may have.

[The prepared statement of Mr. Vaughan follows:]

STATEMENT OF WILLIAM A. VAUGHAN

ASSISTANT SECRETARY OF ENERGY FOR

ENVIRONMENTAL PROTECTION, SAFETY, AND

EMERGENCY PREPAREDNESS

Mr. Chairman, Madam Chairman, and Members of the two Subcommittees:

I appreciate the Subcommittees' invitation to discuss the "Integrity of the Electric Power System." I share your concern with the importance of this topic. As I will discuss, we at DOE believe that we have underway several projects which address these issues in a way which will help assure the viability of the national energy system.

Over the last several months, I have presented extensive testimony concerning various aspects of the Department of Energy's energy emergency preparedness programs. To a large degree, the focus of prior Congressional hearings has emphasized the Nation's ability to deal with disruptions of imported crude oil. However, last May I delivered a statement to the Senate Subcommittee on Energy, Nuclear Proliferation, and Government Processes on the "resiliency" of the Nation's energy supply systems -- in other words, the ability of these systems to recuperate after serious physical disruptions caused by major accidents, natural disasters, sabotage or terrorism.

Today I plan to update that statement by describing some of the recent DOE activities. I will also discuss the Department's role with regard to the integrity of the electric power system.

Based on the studies and reports which have been done in the past, and on recent work done by the Department of Energy in conjunction with other Federal agencies, it is our preliminary view that the Nation's electric power

systems, as well as its other major energy systems, have a significant degree of resiliency. For example, a recent Department of Energy report on storm-related electric power outages discussed the electric utility industry's ability to restore service to their customers quickly after severe storms.* Electric utilities also have proven to be quite capable of providing for electric generation resources that become unavailable for unexpected reasons.

But the fact cannot be ignored that domestic energy systems could experience unexpected disruptions, including those caused by sabotage. With this in mind, and because energy is so critical to national welfare and security, DOE is presently involved in a project assessing the vulnerability to sabotage and accidents of the electric utility network, natural gas and petroleum pipelines, and other parts of the national energy systems.
Briefly stated, our objectives are to work in conjunction with the Congress, other Federal and state agencies and appropriate elements in the private sector to:

- o Identify and develop a technically sound assessment of key energy vulnerabilities;
- o Develop proposals as needed for reducing these vulnerabilities and report on the state-of-the-art of corrective measures;
- o Encourage the appropriate organizations to take actions that will reduce the risks and vulnerabilities; and
- o Prepare to respond appropriately if events occur that are beyond the current level of resiliency of the energy systems.

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* "Analysis of Storm Related Outages & Restoration Measures, Washington, D.C. Metropolitan Area" (DOE/RG/06674-T2), December 1981.

The program is being managed by the Department's Office of Energy Emergencies, with assistance from the Office of Defense Programs, and from other Offices within the DOE, and has been coordinated with many other Federal organizations. Last June, I sent a letter to thirteen Federal departments and agencies informing them of our interest in this subject and requesting comments on a draft program plan. Twenty-two separate responses were received, including twelve from various offices within the Armed Services and the Defense Department. In general, the responses strongly encouraged DOE to proceed with the suggested program plan and did not reveal any duplication of past or current efforts.

More recently, the White House Office of Science and Technology Policy convened a meeting of Deputy Assistant Secretaries and Office Directors representing a number of federal organizations with interest and expertise in various subjects related to energy system vulnerability. This meeting provided an opportunity to share information and ideas on this multi-faceted subject. We are also coordinating closely with certain offices in the Defense Department and the Federal Emergency Management Agency (FEMA) in regard to our vulnerability project.

Most of the effort in this program to date has been concentrated on the electric power system, particularly on the supply of electric power to facilities that are vital to national security. Staff personnel have conducted site visits to a number of critical domestic military bases selected by the Air Force Logistics Command, and have held meetings with the electric utilities serving these bases. These visits were closely coordinated with a separate Air Force-sponsored study by Los Alamos National

Laboratory. Dr. Michael Berger, of Los Alamos, is also testifying here today. Several non-Air Force defense-related sites were also visited.

Subsequently, our staff has conducted a much more detailed technical case study to evaluate the ability of one utility to recover after a major multi-site sabotage attack designed to interrupt power to an Air Force Logistics base. This analysis, which has not yet been completed, involves close cooperation with the utility's technical staff including a week-long series of meetings and site visits. This detailed case study approach, working directly with local utilities, is consistent with suggestions made on various occasions by Mr. Michehl Gent and other representatives of the North American Electric Reliability Council.

Of course, it would not be feasible or worthwhile to evaluate all energy supply facilities at this level of detail. However, we are convinced that conducting a few carefully selected case studies offers the surest way to obtain an accurate assessment of the ability of the power systems to respond to major contingencies caused by hostile acts. Although the focus has been on defense facilities, the analyses also illustrate the potential impacts on other utility customers.

We are also looking at other vulnerability issues relating to the Strategic Petroleum Reserve and, in that connection, we have made site visits to three electric utilities serving key pumping stations of the Strategic Petroleum Reserve.

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Draft reports of these case studies are being prepared and should be ready for external technical review early in 1983. However, because they contain sensitive information concerning specific utility installations and operating procedures, as well as some classified military information, the reports themselves will not be available for general circulation. The key findings will be made available in a form that can not be used as a "blueprint" on how to disrupt energy facilities.

Although it would be premature to discuss the results of the case studies before technical reviews are completed, it has generally been found that a great number of options are available to electric utilities to restore power quickly, particularly to priority customers that are important to public health and safety or to national security. Furthermore, the extensive interconnections within and among utility systems make an important contribution to this resiliency, by providing multiple transmission routes as well as access to a very large number of power sources.

The utilities also have large repair forces, and they maintain inventories of almost all replacement parts, except for certain very large or unique items. They also have standing arrangements with neighboring utilities to share production and repair resources during emergencies. Their facilities are protected by decentralized automatic relaying systems. Finally, during contingencies they can resort to load-shedding, or can even break their system into separate operating regions--called "islands"--so that priority loads can be served even when the system is badly crippled. If necessary, they can also operate adequately without the use of their central control and primary communications facilities. Even when major units are lost and no

spares are available, utility engineers and operators are often quite innovative in "rearranging" assets of the system to minimize or avoid extensive disruptions of service. These preliminary results appear to contradict recent article statements about the resiliency of the Nation's electric power system. In fact it is the same aspects of the electric system that these articles criticize that gives it its resiliency.

In addition to the work on electric power vulnerability, we are beginning a case study of the vulnerability of a major petroleum pipeline.

Besides the case studies, we also have several other related tasks underway to provide general support or to address key issues. For example, our staff is conducting an extensive literature search on many topics related to the vulnerability of energy facilities. This in-house effort will result in a computerized set of titles, abstracts, and technical reviews that will be of continuing use in dealing with this subject. Other tasks underway include an examination of the availability of critical replacement components, as well as a threat assessment study conducted by DOE's Office of Defense Programs and Sandia Laboratory covering the capabilities, limitations and techniques of potential adversaries that might conceivably conduct sabotage or terrorist operations against our energy systems. It is most important to have a clear understanding of the realities of that to which we might be vulnerable.

Although the primary concerns of the program at this point are energy disruptions caused by deliberate hostile acts, we expect many of our results to also be applicable to disruptions caused by natural disasters or accidents that are sufficiently severe to have a serious national impact. On the other

hand, our program is not intended to deal with incidents normally handled by industry or by local authorities--such as vandalism, storms, or equipment failures. Industry has an excellent track record in dealing with such events, and there does not appear to be a need for any extension of Federal involvement.

I do not want to give the impression that we are prejudging the resiliency of the Nation's energy system against acts of sabotage or other disruptions or that we have concluded that there are no serious vulnerabilities. The potential exists that the general population and economy might suffer some level of hardship after a major hostile act against an energy system, even if defense facilities are kept operating. We need to know more about the range of possibilities of disruptions occurring, and potential levels of hardship which might be experienced due to these disruptions.

Let me reassure you on one more point. We recognize that the owners of energy facilities in the private sector have a strong interest in providing a reliable, resilient and secure energy supply system. This interest in avoiding electric power supply interruptions on the part of the private sector is a vital aspect of any overall security system. In conducting our studies, we in DOE intend to respect private sector prerogatives and avoid any hint of harassment or suggestion that the government alone is concerned about security. Without the support and effort by the private sector, energy systems would be much less secure.

Finally, I would like to make a few brief remarks concerning the role of the Department of Energy with regard to emergencies affecting electric power

systems. There appears to be a considerable divergence of views on this subject, as evidenced by recent positions taken by the General Accounting Office. Our view is that the major capabilities for dealing with severe disturbances affecting energy systems lie with the managers and operators of the systems themselves. While the Department of Energy routinely monitors emergency situations and stands ready to assist in various ways, if needed, it is certainly not the principal actor. In fact, by law and Executive Order, the Federal Emergency Management Agency is responsible for coordinating the Federal government's response to civil emergencies.*

For example, after the recent severe storm which hit Hawaii, the President declared a state of disaster and FEMA Region IX was designated to coordinate further actions. A number of Federal agencies, not including DOE, sent representatives to Hawaii to help with various relief measures. DOE monitored the situation closely and was prepared to assist in coordinating certain electric power restoration activities. However, no direct DOE involvement was required. The two local electric companies restored power quickly to most areas. The Navy also provided portable generators to supply power to some key locations. The experience with this storm, as well as with the recent storms in California and with many similar emergencies in the past, suggests strongly that there is no need for a more extensive DOE role either in developing detailed plans or in seeking to manage contingencies.

If a very serious emergency were to occur involving the Nation's electric power or other energy systems, the appropriate Federal response would depend

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* In the absence of a declared civil emergency, DOE can, however, exercise its emergency authority pursuant to Section 202(c) of the Federal Power Act to order electric power transmission and interconnections.

strongly on the particular facts and circumstances confronting the Nation at the time of the emergency. A recent Memorandum of Law, prepared by the Attorney General, summarizes the legal authorities available to the President to respond to a severe energy supply interruption. (This Memorandum was transmitted to Congress by President Reagan on November 15, 1982).

One additional mechanism for responding to energy emergencies that DOE has at its disposal is its three assigned Energy Executive Reserve units. (Electric Power, Solid Fuels, and Petroleum and Gas.) Such reserves are comprised of knowledgeable industry executives who can serve, without compensation, to supplement Federal efforts to seek solutions for mitigating the impact of energy emergencies.

You can be assured that the Department of Energy, and the Administration, take the question of the integrity of the electric power supply system very seriously, and we are vigorously examining the resiliency of this system within the parameters which I have described above.

This concludes my remarks. I would be pleased to respond to any questions which you may have.

Mr. FUQUA. Thank you very much, Mr. Vaughan.

I am very pleased at this time to recognize our colleague, Mr. Skeen, from New Mexico to introduce our next witness.

Mr. SKEEN. Thank you, Mr. Chairman.

I was pleasantly surprised to see my friend, Dr. Berger. We are justly proud of him. He is well qualified. I see that they have prepared a particular group of questions for Dr. Berger. He is from the Los Alamos National Laboratory and a fine scientist.

Welcome, Mike. It is good to see you.

Thank you very much, Mr. Chairman.

Mr. FUQUA. Thank you very much, Mr. Skeen.

We will be pleased to hear from you now, Dr. Berger.

Dr. BERGER. Thank you, Congressman Skeen.

Mr. Chairman, Madam Chairman, members of the subcommittees, I appreciate the opportunity to appear before this committee to provide information about the integrity of electric power systems.

For the past 2 years, we at Los Alamos National Laboratory have been investigating the integrity of all energy systems, mainly to provide a basis for evaluating the energy security of the military. However, since the military is primarily dependent upon commercial energy supplies, we have had to assess their vulnerabilities.

Since the purpose of this hearing is to investigate the technical aspects of the integrity of power production, transmission and distribution systems in relation to major disruptions, I will address the vulnerabilities of the national electrical grid, and the role that technology can play in reducing these vulnerabilities. I will not attempt to evaluate policy decisions, except to indicate where, possibly, technology can play a role in aiding Federal officials in establishing priorities involving policy. In keeping with the guidance I received, I will also not discuss a specific network, a specific commercial facility, nor consider defense installations.

I might mention that I believe this guidance is particularly appropriate because we do not want to write a blueprint for any adversary. However, it does preclude my discussing most of the work that Los Alamos has performed in this particular area.

The integrity of electric power systems has been the subject of several government and popular publications. Common everyday experience tells us that the electric power industry provides extremely reliable service. Except in rare instances, we always get the lights when we flip the switch.

The utility industry has established regional reliability councils and a North American Electric Reliability Council, which has a representative appearing before this committee. In addition, they have established the Electric Power Research Institute, which also has a representative here today, whose purpose is to utilize technology to provide the customer with better, less expensive and more reliable electric service.

There may not be any other industry with a better track record of making reliability its highest priority. The electric power which the utility industry provides is the mainspring of our economy. Reliable electric power is indispensable to provide military readiness, support our industry, homes, and thus our economy. With this in

mind, I think it is therefore appropriate that we do evaluate the integrity of electric power systems.

Even though electric power systems have demonstrated reliability, there is no doubt that they are susceptible to major disruptions and are, therefore, vulnerable. A recent November EPRI journal shows that for load interruptions of at least 200 megawatts, there were 23 major outages in the United States in 1979. This rose to 45 in 1980. For purposes of these remarks, I believe it is not necessary to specify the cause of the disruption, only that it is possible that one exists.

The Government Accounting Office, GAO, defines a major disruption as one that has a major or national impact, is beyond the utility industry's capability to manage on its own, is sudden, unusual, unexpected and prolonged, and be the subject of the declaration of a national emergency. Disruptions falling within this definition can be caused by natural occurrences, sabotage, war or terrorism. The major disruptions to date have been caused by natural occurrences, and most of those that I mentioned are not considered major by the GAO definition. When I speak of disruptions today, I will consider disruptions that are perhaps not as extensive as those included in the GAO definition.

We note the vulnerability of electric power systems every day. Transmission lines, substations and transformers are visible everywhere. It would be virtually impossible to provide physical security for all of these critical components of the electrical distribution system. Robert Kupperman, executive director of the Georgetown University Center for Strategic and International Studies, has noted the vulnerability of electric power systems in discussions with us at Los Alamos, and believes that perhaps one way of improving the integrity of the system is to stockpile critical components, such as transformers, that utilize critical materials rather than stockpiling critical materials themselves. Power generating stations are more secure and can be made more so. I think it is appropriate to ask also what roles technology can play in improving system integrity.

Although it has been noted that the integrity of the electric power system can be destroyed by disruptions, it is difficult to assess what the impact of these disruptions will be on the stability of the national electrical grid. I am defining a system to be stable when a disruption at one location can be managed either by containment or by the ability of the rest of the system to absorb the perturbation caused by the interruption. Thus, the effect of the disruption does not cascade across the system causing further problems.

We will probably hear later from the representatives of the Electric Power Research Institute and the North American Electrical Reliability Council concerning their efforts to evaluate stability of the electric power system. They will probably mention that stability, as I have mentioned, is an everyday problem for the utility industry. The regional committees that comprise the North American Electrical Reliability Council has computer codes which allow them to evaluate stability on a regional basis. In addition, the Electric Power Research Institute is working on a code which covers the entire national system and will allow them to evaluate the

impact of disruptions. This code is presently small, but they do have plans to upgrade it to a larger computer program.

These problems require the best of present-day computers and one run may cost more than $1,000. Utility planners need to run hundreds of these calculations to maintain stability of the system. It may be in the national interest to have an even larger capability for stability analysis. Such a computer code would require the best supercomputers and the most advanced solution techniques. This program would be available for modeling the national electrical network for a wide variety of considerations. For example, the model could be used to evaluate the impact of a major disruption or a series of coordinated disruptions to see how they cascade across the country and to determine what preventive actions are necessary for isolation.

It is also possible that this model could be used to evaluate the impact on stability of distributed, small power systems as envisioned by the Public Utilities Regulatory Power Act if there were a large shift to alternative technologies that are recommended by some who have studied the problem.

Heuristically, one would think that a shift to dispersed alternative technologies would make the electric power system more reliable and more stable. However, due to the complexity of the problem, this may not be true. I think it is difficult to make general statements about a system that is complicated and complex and with as many interties as the national electrical system without a sophisticated analysis. If such a model were available, it could be considered to be a national asset and could be utilized to get priorities and plan for the potential occurrence of major disruptions.

Finally, a sophisticated analysis tool could be utilized to evaluate new technologies that could be used to reduce vulnerabilities to the electric power system. Technologies that are intended to enhance the integrity of the system are currently under development in industry, universities, and national laboratories, funded both by the Electric Power Research Institute and the Department of Energy's Office of Energy Systems Research.

An example of one such technology would be to utilize large superconducting magnets as the key component for a fault current limiter. Such superconducting magnets have been developed by the Los Alamos National Laboratory and General Atomics Corp. for the superconducting magnetic energy storage, or SMES, program. The SMES technology itself was developed under the sponsorship of the Department of Energy's Office of Energy Systems Research to provide stability for the Bonneville Power Administration's electrical systems. This committee has supported the SMES program and is familiar with the technology.

In collaboration with Westinghouse Corp., Los Alamos has pursued the concept of a superconducting fault current limiter. We believe that a superconducting fault current limiter could have prevented an occurrence such as the 1977 New York blackout. However, an analysis tool would permit us to verify this contention. We concluded in our studies that a superconducting fault current limiter is technically feasible, but the expense is such that it would not be economically attractive to the utilities.

Since the integrity of the national electric system is of such vital importance to national security, it may be that the Federal Government's role should be expanded to assess and develop new technologies that reduce the vulnerabilities. In our energy vulnerability assessments, it was very clear that the capability of each utility to respond to a disruption is quite different.

For example, we found that some utilities have mobile substations that could be employed and connected within a few hours while others had few spare transformers and replacements could not be obtained for several months. In addition, the priorities for establishing service to key installations vary with each utility. Therefore, it may be appropriate for the Federal Government to assist in the development of new technologies and perhaps even emplace them in those locations that are critical for maintaining national security. A model as previously described would be useful in evaluating these new technologies and their benefit to the electric power system.

In the longer term, basic research in technology is needed to:

Enhance information processing and rapid assessment of systems condition during and after major disruptions;

Develop advanced control methods to minimize impact of major disturbances—for example, photoconducting electronics can sense and switch a pico-second timeframe;

As I previously mentioned, we need to explore analytical tools to aid system operators in determining secure and stable alternatives for rapid restoration of service following total loss of service to large areas;

Develop improved materials for surge protection devices on power systems to enhance protective characteristics and reduce thermal losses;

Provide advanced overhead and underground transmission technology leading to enhanced capacity and reliability so as to maximize utilization of limited rights-of-way and reduce vulnerability to major disturbances;

Determine fundamental processes leading to aging of insulation system and devising methods to limit the aging process;

Finally, develop electronic systems that have the capability to tolerate high levels of radiation.

Some of these areas I have mentioned overlap.

This concludes my remarks. Thank you for the opportunity to appear before this committee, and I welcome any questions you might have.

[The prepared statement of Dr. Berger follows:]

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REMARKS OF MICHAEL E. BERGER
DEPUTY ASSOCIATE DIRECTOR
ALTERNATIVE ENERGY SOURCES
LOS ALAMOS NATIONAL LABORATORY
BEFORE THE
SUBCOMMITTEE ON ENERGY DEVELOPMENT AND APPLICATIONS
AND ENERGY RESEARCH AND PRODUCTION
OF THE
HOUSE SCIENCE AND TECHNOLOGY COMMITTEE

December 9, 1982

Mdm. and Mr. Chairmen, Members of the Committee:

I appreciate the opportunity to appear before this committee to provide information about the integrity of electric power systems. For the past two years, we at Los Alamos National Laboratory have been investigating the integrity of all energy systems, mainly to provide a basis for evaluating the energy security of the military. However, since the military is entirely dependent upon commercial energy supplies, we have had to assess their vulnerabilities. Since the purpose of this hearing is to investigate the technical aspects of the integrity of power production, transmission, and distribution systems in relation to major disruptions, I will address the vulnerabilities of the national electrical grid, and the role that technology can play in reducing or eliminating these vulnerabilities. I will not attempt to evaluate policy decisions except to indicate where technology can aid federal officials in establishing priorities and improving policy. In keeping with the guidance I received, I will also not discuss a specific network, a specific commercial facility, nor consider defense installations.

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The integrity of electric power systems has been the subject of several government and popular publications (Ref. 1-6). Common everyday experience tells us that the electric power industry provides extremely reliable service. Except in rare instances, the lights always turn on when we flip the switch. The utility industry has established regional reliability councils and a North American Electric Reliability Council, which has a representative appearing before this committee. In addition, they have established the Electric Power Research Institute (EPRI), which also has a representative here today, whose purpose is to utilize technology to provide the customer with better, less expensive, and more reliable electrical service. There may not be any other industry with a better track record of making reliability its highest priority. The electric power which the utility industry provides is the mainspring of our economy. About 30% of the nation's energy requirements is produced by electricity. As noted in a recent Government Accounting Office (GAO) report (Ref. 1), "Without power, everything in our modern society naturally grinds to a halt. For example, electricity is an integral component of our transportation, communication, and distribution systems. Manufacturing and food production rely heavily on electricity and the American standard of living is tied to the use of electrical energy. Electric power is indispensable to maintaining our nation's military readiness and running our

- defense industry
- gasoline refineries and stations
- manufacturing plants
- computer systems
- hospitals, office buildings, and airports
- water and sewage treatment plants
- mass transit and traffic control systems
- home heating, lighting, and cooking."

With this in mind, it is therefore appropriate that we evaluate the integrity of our electric power systems.

Even though electric power systems have demonstrated reliability, there is no doubt that they are susceptible to major disruptions and are vulnerable. Figure 1, taken from a study performed for the Department of Energy's Office of Energy Systems Research, indicates that the number of disruptions over 100 MW shows a significant increase in recent years (Ref. 5). For load interruptions of at least 200 megawatts, there was 23 major outages in the United States in 1979. This rose to 45 in 1980 (Ref. 7). For the purpose of these remarks, I believe it is not necessary to specify the cause of the disruption, only that it exists. The GAO defines a major disruption as one that has a mjaor national/regional impact, is beyond the utility industry's capability to manage on its own, is sudden, unusual, unexpected, and prolonged, and be the subject of the declaration of a national emergency. Disruptions falling within this definition can be caused by natural occurances, sabotage, war, or terrorism. The majority of major disruptions to date have been caused by natural occurances, and most of those shown in Figure 1 are not considered major by the GAO definition.

We note the vulnerability of electric power systems everyday. Transmission lines, substations, and transformers are visible everywhere. It would be virtually impossible to provide physical security for all of these critical components of the electrical distribution systems. Power generating stations are more secure and can be made more so. Robert Kupperman, Executive Director of Georgetown University's Center for Strategic and Internationl Studies, notes the vulnerabilities of electric power systems and believes that one way of improving the integrity of the system is to stockpile critical components, such as transformers, that utilize critical materials rather than stockpiling critical materials

themselves. In addition, it is appropriate to ask what roles that technology can play in improving system integrity.

Although it has been noted that the integrity of the electric power system can be destroyed by disruptions, it is difficult to assess what the impact of these disruptions will be on the stability of the national electrical grid. I am defining a system to be stable when a disruption at one location can be managed either by containment or by the ability of the rest of the system to absorb the perturbation caused by the interruption. Thus, the effect of the disruption does not cascade across the system causing further problems.

We will probably hear later from the representatives of EPRI and the North American Electrical Reliability Council (NERC), concerning thei efforts to evaluate stability of the electric power systems. If I may paraphrase some of what may be said, the concern over stability is an ongoing everyday problem since reliability is a high priority of the electric utilities. The North American Electrical Reliability Council has computer codes which allow them to evaluate stability on a regional basis. These codes have been developed by the industry and are not necessarily in the public domain. In addition, EPRI is working on a code which covers the entire national system and which will allow them to evaluate the impact of disruptions. This code is presently small, approximately 150 nodes, but EPRI has plans to upgrade it to about 1500 nodes. As noted in the November 1982 EPRI journal (Ref. 7), the stability problem is not necessarily difficult; rather it is large. It points out that these problems require the best of present day computers, and that one run may cost more than $1,000. The utility planners need to run hundreds of these calculations to maintain stability of the system. It may be in the national interest to have an even larger capability for stability analysis. Such a computer code would require the best supercomputers and the most advanced solution techniques. This computer program would then be available for modeling the national electrical grid for a wide variety of considerations. For example, the model could be used to evaluate the impact of a major disruption, to see if it cascades across the country and to determine

What preventive actions are necessary for its isolation. It is possible that this model could be used to evaluate the impact on stability of distributed, small power systems as envisioned by the Public Utilities Regulatory Power Act (PURPA) if there were a large shift to alternative technologies are recommended by some who have studied the problem (Ref. 3). Heuristically, one would think that a shift to dispersed alternative technologies would make the electric power system more stable. However, due to the complexity of the problem this may not be true. It is difficult to make general statements about a system that is as complicated and with as many interties as the national electrical system shown in Figure 2 without a sophisticated analysis. If such a model were available, it could be considered to be a national asset and could be utilized by setting priorities and planning for the potential occurrence of major disruptions. Such planning has been called for by the GAO in its two recent reports to the Congress (Ref. 1-2).

Finally, a sophisticated analysis tool could be utilized to evaluate how new technologies could reduce or eliminate vulnerabilities to the electrical power system. Technologies that are intended to enhance the integrity of the system are currently under development in industry, universities, and national laboratories, funded both by EPRI and the Department of Energy's Office of Energy Systems Research. An example of one such technology would be to utilize large superconducting magnets as the key component for a fault current limitor. Such superconducting magnets have been developed by the Los Alamos National Laboratory and

General Atomics Corporation for the Superconducting Magnetic Energy Storage (SMES) Program. The SMES technology itself was developed under the sponsorship of the Department of Energy's Office of Energy Systems Research to provide stability for the Bonneville Power Administration's electrical systems. This Committee has supported the SMES Program and is familiar with the technology. In collaboration with Westingnouse Corporation, Los Alamos has pursued the concept of a superconducting fault current limitor (SCFS). We believe that an SCFS could have prevented an occurrence such as the 1977 New York blackout. An analysis tool would permit us to verify this contention. We concluded that an SCFS is technically feasible, but the expense is such that it would not be economically attractive to utilities. Again, better analytical tools would have assisted in such an evaluation.

Since the integrity of national electric system is of such vital importance to national security, it may be that the federal government's role should be expanded to assess and develop new technologies that reduce the vulnerabilities. In our energy vulnerability assessments, it was very clear that the capability of each utility to respond to a disruption is quite different. For example, we found that some utilities have mobile substations that could be employed and connected within a few hours while others had no spare transformers, and replacements could not be obtained for several months. In addition, the priorities for establishing service to key installations vary with each utility. Therefore, it may be appropriate for the federal government to assist in the development of new technologies and perhaps even emplace them in those locations that are critical for maintaining national security. A model as previously described would be useful in evaluating these new technologies and their benefit to the electric power system.

In the longer term, basic research is needed to:

- o Enhance information processing and rapid assessment of systems condition during and after major disruptions.
- o Develop advanced control methods to minimize impact of major disturbances; for example, photoconducting electronics can sense and switch on a nanosecond time frame .
- o Explore analytical tools to aid system operators in determining secure and stable alternatives for rapid restoration of service following total loss of service to large areas.
- o Develop improved materials for surge protection devices on power systems to enhance protective characteristics and reduce thermal losses.
- o Provide advanced overhead and underground transmission technology leading to enhanced capacity and reliability so as to maximize utilization of limited rights-of-way and reduce vulnerability to major disturbances.
- o Determine fundamental processes leading to aging of insulation systems and devising methods to limit the aging process.
- o Develop electronic systems that have the capability to tolerate high levels of radiation.

18-363 O—83——3

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Significant U.S. Electric Power Systems

INTERRUPTIONS AND HAZARDS

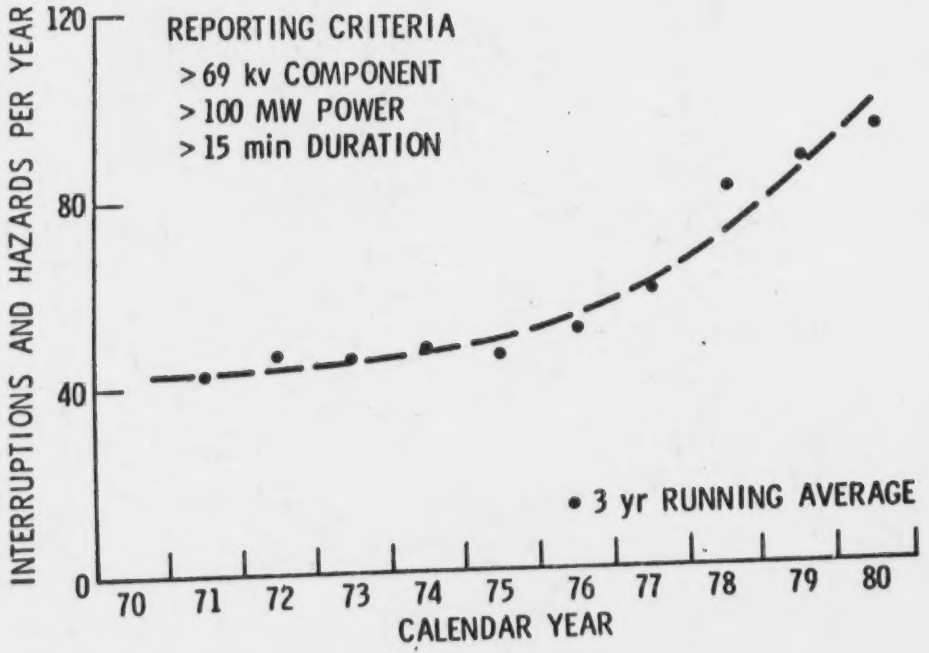
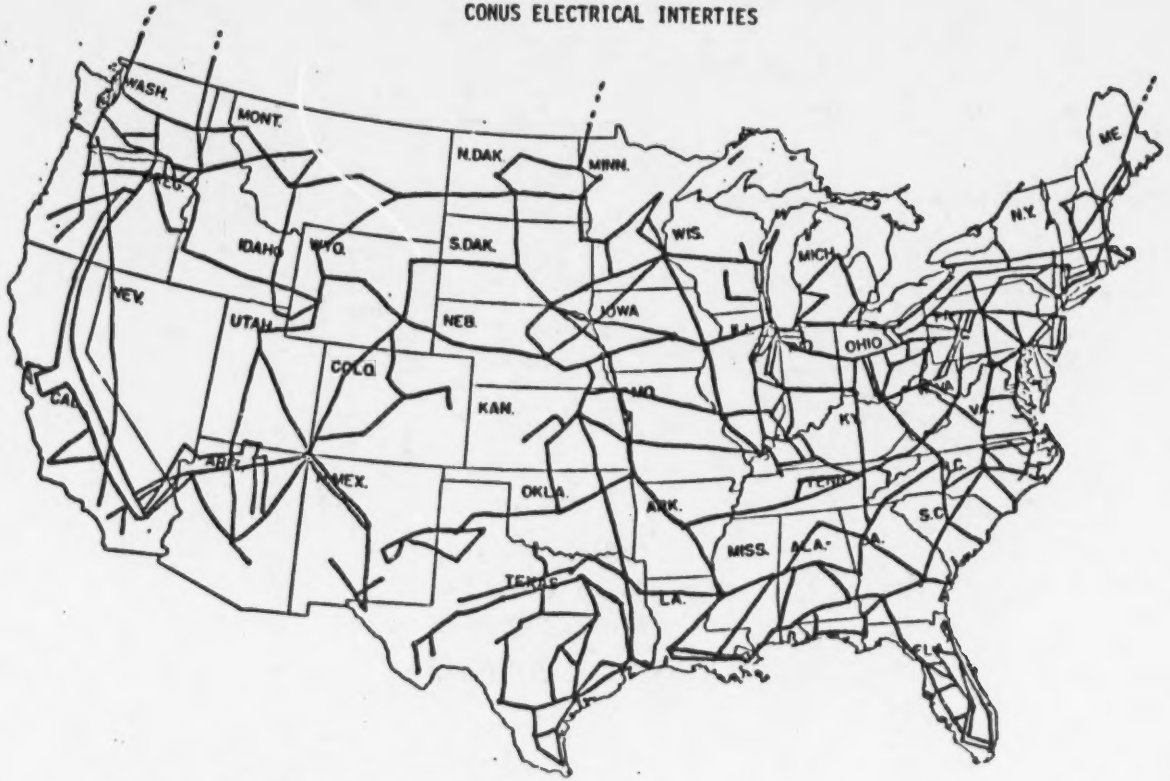


Figure 1

CONUS ELECTRICAL INTERTIES



Source: Adapted from EPRI JOURNAL, March 1979

Figure 2.

Mr. FUQUA. Thank you very much, Dr. Berger.

Mr. Gent.

Mr. GENT. Mr. Chairman, Madam Chairman, members of the joint subcommittees, I truly appreciate this opportunity to speak to you today on the integrity of electric power systems. My oral statement is very short. My written statement is short also.

However, everyone today has mentioned the North American Electric Reliability Council, so you must know that NERC was created many years ago, in 1968, to insure and promote reliability and adequacy of supply of the electric utility bulk power supply system.

I am not going to cite our achievements and the reasons we are organized. I will refer you, if you are interested, to an attachment to my written testimony that was presented to your subcommittees by our previous chairman, Mr. Walter Brown, back in June. Additionally, Mr. Winn, who follows me, will cite some of our activities.

The electric utility systems in North America may not be as vulnerable as you have been led to believe. We do not have a centralized system, but rather what we have is a bottoms-up system that is highly coordinated. There is no central location; there is no centrally located center that controls North America. Because we have common rules, practices and procedures, guidelines and criteria that we have all met with and agreed to and we all operate by the same rules, it gives that appearance that we are highly centralized.

Consider the diversity of our industry. There are over 11,000 operating units interconnected with one another serving the United States and Canada. There are over 560,000 miles of high-voltage transmission lines—that is, transmission lines that are 230 kV and above. There are over 3,500 electric utilities in the United States and Canada, most of those in the United States. This would be an incredibly complex task to try to manage these 11,000 units, 3,500 utilities, and these half-million miles of lines without reorganizing them into controlled areas. So we have 153 control areas in the United States and Canada that operate our electric systems.

Even the basic elements of an electric system are often misunderstood. You have heard—or will hear—that most of the interruptions to customers come from disruptions to our distribution systems. Mr. Winn will cite some examples of the TVA system. These distribution systems are connected to transmission systems. Also connected to a transmission system is a generating plant of some kind. Very often, an electric utility will need more reliability or decide that he should interconnect with a neighboring utility and, to do this, he will build an interconnection with a neighboring utility to his transmission system. It is this series of interconnections, one utility to another, that have been constructed for emergency purposes that are often referred to as a grid. The electric utility industry tries to call it a network.

In my written testimony, I try to suggest where research would be helpful. The electric utility industry is blessed to have an organization like the Electric Power Research Institute, and Mr. Iveson will talk for them here today. So I am really hard pressed in my position to find a role where government research would be useful.

However, I don't want to leave you empty handed. We have a vast amount of resources in the North American Electric Reliability Council. I would like to offer here today to you and your staffs

the complete cooperation of that organization as you look into these matters of electric liability further.

That concludes my statement, Mr. Chairman.

[The prepared statement of Mr. Gent follows:]

STATEMENT OF
MICHEHL R. GENT - PRESIDENT
NORTH AMERICAN ELECTRIC RELIABILITY COUNCIL
BEFORE THE
SUBCOMMITTEE ON ENERGY DEVELOPMENT APPLICATIONS
AND THE
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
COMMITTEE ON SCIENCE AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES
DECEMBER 9, 1982

Mr. Chairman, members of the Joint Subcommittees, I appreciate the opportunity to comment on the integrity of electric power systems.

Fortunately, I had the opportunity to review a draft of the comprehensive presentation planned to be presented to these Subcommittees by Mr. Charles E. Winn, who has been a leading contributor and participant in the development of NERC criteria and objectives since 1968. Had I not seen this draft, I would have burdened the Subcommittee with restatements of essential facts that will already be incorporated in Mr. Winn's statement. To this end, it also seemed appropriate to include a copy, for your convenience, of the testimony of Walter D. Brown, my predecessor as President of NERC, presented to these Subcommittees during joint hearings on June 10, 1982. In Mr. Brown's testimony, which addressed "U.S. Electric Power System Reliability", Mr. Brown discussed the history of NERC and the Council's activities and accomplishments in promoting power system reliability. I fully concur with the statements submitted by both Mr. Winn today and Mr. Walter D. Brown on June 10, 1982.

This allows me to focus on findings that relate to the present and future integrity of the Nation's electric power systems. There are a few additional facts that should be brought to your attention:

- There are over 11,000 generating units serving the interconnected power systems in the United States and Canada; capable of delivering over 650,000 MW of electric power.

- There are over 156,000 miles of high voltage transmission lines, 230 kV to 765 kV, that provide the vehicle for delivering the electric power from remote generating source and neighboring systems to the ultimate consumer.
- There are over 3,500 electric utilities that own the generation and transmission facilities in the United States and Canada.
- To manage this incredible diverse combination of complex sources, there are 153 Control Areas that control the output of the 11,000 generating units and control the electric power flow over the 156,000 miles of high voltage transmission lines.

Indeed, the integrity of the Nation's electric power systems would be in jeopardy if it were necessary to coordinate the operation of the interconnected power systems of the United States and Canada through the 3,500 electric utilities involved. The reduction of the overall control function to only 153 Control Areas is the result of increased coordination made possible by innovative pooling arrangements, interconnection agreements, and the adoption of industry standards, principles and procedures such as those set forth in our NERC Operating Manual.

The integrity of the electric power sytems, in their existing configuration, is greater now than ever in the history of either interconnected or isolated electric power systems. It is believed by many that this integrity will be enhanced even further if the number of Control Areas could be reduced, from the present 153 to less than 50. The determination of the optimum number of Control Areas has not been pursued since legislative and institutional factors preclude any possibility of approaching that number in the near future. We do know from the experience gained in the highly coordinated

Northeast Region that there is a point of diminishing returns. For example, it is unlikely that the Northeast Power Coordinating Council Region, which includes New York State, New England States, Ontario, New Brunswick and Quebec, would gain from any reduction in the number of Control Areas. At present, there are five Control Areas that serve this vast geographic area.

The Control Area is the purest form of an electric power system; all entities within an area are subject to the same operating principles, practices, and procedures. A Control Area may be a Municipal power system, an investor-owned electric utility, a Federal agency, an electric power cooperative, or a combination of these and other entities engaged in the production, transmission and distribution of electric energy.

It was the quest to achieve greater reliability at a reasonable cost that motivated the interconnection of these various forms of Control Areas. Such interconnections would not have been possible without the creation of the Control Area concept and the development of industry standards of performance. Control Areas vary in size; influenced by geographic factors, load densities, and the existing configuration of generation and transmission facilities. Loads served by a given Control Area range from as low as 35 MW to as high as 35,000 MW.

It is through the vehicle of the Control Centers at any of the 153 Control Areas that the security of a particular critical load can be assessed and suitable remedies developed. As you know, the Department of Energy (DOE) and the Federal Emergency Management Agency (FEMA) have been criticized for not producing "a National plan to cope with problems caused by a loss of electricity". I suggest that it would be impossible to develop such a generic plan. Fortunately, I can also suggest that a generic plan is not necessary.

Establishing priorities to the loads served in a given Control Area is a routine functional responsibility of the management of that Control Area. Decisions are made after consultation with hospitals, police departments, fire departments, defense agencies, and other State and Federal agencies. The fact that these consultations and developed remedies are not widely publicized should not be surprising. There may be some value in a joint Federal and State determination of priority of service among various end users. For instance, it would be helpful to know that government considers police departments a higher priority than hospitals or visa-versa, prior to the time that it is necessary to make an instant decision.

Even though the members of these Subcommittees are scientifically oriented, it would seem appropriate to state a basic fact for the record:

> There are virtually no technical constraints to the construction and operation of a totally reliable electric power supply.

The constraints are predominantly economic since the cost of constructing such a system would far exceed the value of the incremental benefits received. However, there are examples where the reinforcement of the bulk power transmission system were constrained by the regulatory process even though the proposed reinforcement enhances the integrity of the bulk power network and would significantly reduce electric production costs as well as conserve the use of premium fuels. For example:

> [1]Recently the bulk transmission system in central MAAC was strengthened by completion of the Hosensack-Elroy 500 kV line after a seven year delay. The final obstacle was overcome with

[1]NERC 1981 Annual Report (page13).

resolution of a legal appeal by one property owner who alleged that the line's electric and magnetic fields would cause adverse health effects.

[2]Completion of the Baltimore-Washington 500 kV loop has been further delayed from 1984 to 1986 operation. The final segment was certified in 1980 but faces continuing delays due to appeals filed in several county courts. The 500 kV transmission loop is vital to the reliability of the MAAC system. This additional 500 kV transmission will improve stability in the Baltimore-Washington area and increase the transfer capability from the ECAR and SERC regions.

The delay in the completion of the Hosensack-Elroy 500 kV line increased electric production cost to that area by about $200,000 per day. It remains to be seen what impact on the cost of production and the reliability of electric power supply to the vital loads in the Washington D.C. area will be.

America's electric power supply system is the finest in the world. The electric utility industry has proven that it can handle hurricanes, tornadoes, cold weather, hot weather, riots and fuel supply disruption. Government and industry have also demonstrated the ability to work constructively together during these emergencies. I truly believe that America's electric supply system is the most reliable and secure of all our energy supply systems. The electric utility industry has learned from earlier mistakes and been prudent in taking advantage of new developments in the state of the art.

[2]NERC 12th Annual Review (page 37).

If I were asked where additional effort should be focused to improve the integrity of the Nation's electric power systems, I would suggest the review of possible conflicts between Federal and State goals. For example, it is highly probable that if Federal and State regulatory agencies could become more knowledgeable of regional concepts and the need for reliability and adequacy, they would be more effective in sponsoring a secure and economic bulk power supply than could be achieved through the existing Federal and State regulatory process. This concept is well worthy of the Subcommittee's consideration.

Biographical Sketch of Michehl R. Gent

Mr. Gent is the recently elected President of the North American Electric Reliability Council (NERC), having previously served NERC as its Executive Vice President. The Council is a non-profit corporation with headquarters in Princeton, New Jersey. Nine regional reliability councils located throughout the United States and Canada are the owners. NERC, through its regional council concept, is responsible for coordinating many of the planning and operating activities of the electric utilities in the United States and Canada. NERC exists to promote an adequate and reliable bulk power supply systems.

Prior to joining NERC in 1980, Mr. Gent served for seven years as the General Manager of the Florida Electric Power Coordinating Group - a voluntary power pool concept for all of Florida's electric utilities, which, due to its uniqueness and successes, has been the subject of several recent reports on power pooling. He was the first employee of that organization and played a major role in its development.

Before Florida, Mr. Gent worked for ten years with the Los Angeles Department of Water & Power. There, he held several responsible positions in both operations and planning.

He holds degrees in engineering and business from Texas A & M, The University of Southern California, and UCLA and has taught in the graduate schools of USC and Loyola. He has authored several technical papers, is a registered professional engineer and belongs to several professional and honor societies.

December 3, 1982

Attachment to Michehl R. Gent's Testimony

Testimony of Walter D. Brown, President
North American Electric Reliability Council
Before the Joint Hearing of
Subcommittees on Energy Development and Applications
and Energy Research and Production
U.S. House Committee on Science and Technology

June 10, 1982

Mr. Chairman, I am Walter D. Brown, President of the North American Electric Reliability Council, usually referred to as NERC, with headquarters in Princeton, New Jersey. We appreciate the opportunity to respond to your invitation to present testimony and appear before this joint hearing of the Subcommittees on Energy Development and Applications and Energy Research and Production on the topic, "U.S. Electric Power System Reliability". NERC is totally involved in reliability and adequacy of bulk power supply, and I will discuss the Council's activities and accomplishments in promoting system reliability. I will also offer some comments on R&D as it relates to reliability.

As President of NERC, I am charged with being a spokesman for the total electric utility industry on matters relating to the reliability and adequacy of the electric bulk power supply systems in North America. It would be naive to suggest that every utility system has an identical conclusion on every detail relating to such matters. On the other hand, there is no greater dedication of effort nor unanimity of conclusions by the executives and engineers of the total electric utility industry than in matters which promote the reliability and adequacy of the bulk power supply systems in North America.

NERC was created by the electric utility industry in 1968 specifically to promote the reliability and adequacy of bulk power supply in the electric utility systems of North America. The Council is composed of nine regional reliability councils encompassing virtually all of the electric power systems in the United States and Canada (see attached map).

The creation of NERC by the industry was in response to a recognized need to provide a forum to deal with the reliability of the interconnected networks, following the 1965 blackout in the Northeastern United States and Ontario, Canada, and the blackout in the Pennsylvania-New Jersey-Maryland Interconnection in 1967.

Generally, NERC defines reliability and adequacy as separate but interdependent aspects of the bulk power supply system of the electric utility industry in North America. RELIABILITY involves the security of the interconnected transmission network and the avoidance of uncontrolled cascading tripouts that may result in widespread power interruptions. ADEQUACY refers to having sufficient generating capability to meet the electric demands of all customers.

One of the key words which describes the functioning of NERC and its nine regional councils is "Coordination": coordination of planning such that each council reviews the plans of new facilities proposed by each system to assure that such new facilities are compatible with the interconnected network. Especially the review is to determine that such facilities will not have an adverse impact on other systems. Through the Operating Guides under the cognizance of the NERC Operating Committee there is coordination of operations. Furthermore, the NERC forum provides a mechanism for the coordination of planning functions with operating functions. All of these activities are necessary to promote reliability.

Fundamentally, it is through these activities - - plus efforts of various multiregional groups within NERC - - that the reliability of the bulk power system is protected and enhanced.

Initial efforts of NERC, after its formation, working with the regional councils, were directed toward resolving the problems which lead to cascading tripouts of transmission lines and widespread blackouts. Various actions were taken: criteria were reviewed and, in some cases, revised, underfrequency load shedding relays were widely

installed and their settings coordinated, changes were made in protective devices, and operating guides were revised.

Through these and other efforts, we firmly believe that the cascading problem is well in hand. Obviously, if reliability or security of the bulk power system is to be maintained, it will require continuous attention -- and NERC and its regional councils are resolved to do whatever is necessary to protect the reliability of the systems. It is important to add that NERC, with its access to all the expertise in the industry, is the best organization for this assignment -- and in fact the only organization capable of doing it.

Let me now make some comments relating to the "Adequacy" of bulk power supply. NERC has undertaken numerous studies to evaluate both short term and longer term adequacy. Starting several years ago, we have issued reports just prior to each peak load season, summer and winter. In fact, just last week a report was released: "1982 Summer Assessment of Overall Reliability and Adequacy of Bulk Power Supply in the Electric Utility Systems of North America". The report's conclusions were rather brief. In part it said: ". . . bulk power supply in the electric utility systems of North America will be adequate to meet projected summer peak demand and electric energy requirements. Further, the interconnected transmission networks have sufficient strength and flexibility to avoid widespread cascading interruptions and to deliver power and energy to generation deficient areas should emergencies arise."

It has been our intent and policy to be candid in these assessments. For the U.S. as a whole, the summer is the peak load season and the actual peaks cannot be predicted precisely because they are determined in large part by the weather conditions which occur. Nevertheless, at the present time there exists adequate reserve generating capacity to accommodate these variations in peak load requirements as well as to deal

with operational problems due to equipment malfunctions and disturbances on the transmission network caused by lightning and other weather conditions.

As to longer term assessments, NERC has annually, since 1971, made a study of adequacy of bulk power supply looking ten years or more into the future. With your permission I would like to submit the following report for the record: "11th Annual Review of Overall Reliability and Adequacy of the North American Bulk Power Systems." This report is the latest of such reports. The 12th Annual report is presently in the final draft stage and will be released later this summer.

Both the 11th and 12th Annual reports conclude that for the short term there is adequate generating capacity installed and operable. Further, it indicates that plans for future additional generating units would provide an adequate capability to meet presently forecasted load requirements. The report, however, expresses serious concern about future adequacy for much the same reasons indicated in the Charter for these hearings: cancellations and delays in installation of new generating units and unforeseen increases in electric power demand. In addition, the report postulates serious impediments to the completion and operation of new nuclear and coal-fired generating base load units. It also emphasizes that the financial capability of most systems places a limit on their ability to construct needed new bulk power facilities. It would be appropriate to comment here that new generating units are needed not only to meet peak load requirements but to supply energy requirements throughout the year.

Perhaps the greatest threat to an adequate bulk power supply for the future is the long lead time to bring new generating units into service from final planning decisions to commercial operations. The Chairman of NERC commented recently that a way must be found to substantially reduce the lead time in installing new generating and transmission facilities if we are to have any hope of providing an adequate power

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supply for the future. With lead times of as long as 12 or more years, it is humanly impossible to accurately forecast future needs. Materially reduced lead times would ease the impact of the uncertainty of the future and also lessen the financial burden on customers as well.

Realistically, the only options for new generating units available to the utility industry are nuclear and coal-fired units. Other organizations will no doubt address issues involving nuclear units. There are many potential impediments to the construction of new coal-fired generating units. In addition to the very siting of such units, environmental issues abound. Most recent is the issue of acid rain, a phenomena which has been approached with perhaps more emotion than with facts. The industry, on its own and with the assistance of the Electric Power Research Institute (EPRI), has for some time been spending a great deal of money and effort to gather scientific data to determine the formation, transportation, and effects of acid rain. The scientific community is far from agreement on the cause and effect of this phenomena.

NERC has serious concern for the future adequacy of bulk power supply if various acid rain legislative proposals were to require massive retrofitting of generating plants. Even if the cost of such a requirement were not an issue, it would obviously shift money to that project away from new construction programs. In addition, some amount of generating capacity would be prematurely retired, compounding the adequacy problem.

The study of the acid rain problem should have a high priority R&D program lest the industry be forced into a program which may not make any noticeable improvement to the acid rain situation.

The founders of NERC exhibited great foresight when they created an organization which encompassed the nine regional councils. The officers and staff of

NERC work through the officers and staffs of the regional councils, which in turn, work with the individual systems. Furthermore, the members of the NERC Board of Trustees and officers of the regional councils are chief executives or high level executives of their respective utility systems. This combination provides a most effective administrative arrangement which puts NERC in a position to collect credible data and information necessary to analyze and appraise any situations relating to the reliability and adequacy of bulk power supply.

NERC has proven to be dynamic and capable of dealing with different problems in a credible manner. Various documents are issued on a regular basis and specific issues are addressed as they arise. For example, NERC appraised the potential impact on reliability prior to the national coal strikes in 1977 and 1980 and made an after-the-fact analysis after the strikes. NERC appraised the results of the transfer of coal-fired energy to displace oil to document the effectiveness of the industry in saving some 300,000 to 400,000 barrels of oil per day through such transfers of energy over the transmission network.

Several years ago, NERC took over the responsibility of the Generating Availability Data System (GADS). This program is being continually strengthened to provide a credible documentation of the availability records of generating units industry wide. This effort is expected to result in improved availability of generating units as design and operating engineers throughout the industry apply their expertise to remove or minimize the causes of forced outages and unavailability. Much research is being pursued to improve the performance of the components in a generating plant, the characteristics of fuel, and the combustion process. Any progress which will increase the availability of operating units will be beneficial in the overall economics and reliability of the supply of electricity.

Attached is a listing of recent NERC reports. All reports are distributed widely to industry personnel, governmental agencies, and any other interested persons.

NERC and the regional councils have worked closely with Department of Energy representatives to keep them abreast of reliability and adequacy matters.

NERC has been called upon by government to serve as a resource to the Emergency Electric Power Administration in the event of a national defense emergency. To meet the nation's needs for electric power during such emergencies, certain members of the NERC staff and regional council staffs will be asked to serve as "special government employees serving without compensation". NERC also works closely with EPRI to provide data and information as a basis for any of their R&D activities. We also maintain liaison with the three utility trade associations: American Public Power Association (APPA), Edison Electric Institute (EEI), and National Rural Electric Cooperative Association (NRECA). We are a source of various data, information, analysis, and appraisals for the electric utility industry on reliability and adequacy matters. We have attempted to remain objective and to maintain credibility.

In conclusion, we are dedicated, to the best of our ability, to maintain a reliable and adequate bulk power supply system in North America in spite of obstacles and the uncertainties that exist. We believe that electricity is a fundamental ingredient of the economic health of any industrialized nation and an essential requirement of the health and welfare of citizens. We believe a reliable and adequate power supply is a necessity for the national security of a nation.

I find it hard to understand the argument by some who would claim the utility industry is "too reliable". It seems to me that most people find many, if not most, other products and services of poor quality. Surely, it is the prudent policy of any nation which has a quality electric power supply system to assure its continuance.

NORTH AMERICAN ELECTRIC RELIABILITY COUNCIL

ECAR
East Central Area Reliability Coordination Agreement

ERCOT
Electric Reliability Council of Texas

MAAC
Mid-Atlantic Area Council

MAIN
Mid-America Interpool Network

MARCA
Mid-Continent Area Reliability Coordination Agreement

NPCC
Northeast Power Coordinating Council

SERC
Southeastern Electric Reliability Council

SPP
Southwest Power Pool

WSCC
Western Systems Coordinating Council

The North American Electric Reliability Council (NERC) was formed by the electric utility industry in 1968 to promote the RELIABILITY and ADEQUACY of bulk power supply in the electric utility systems of North America. NERC consists of nine Regional Reliability Councils encompassing essentially all of the power systems in the United States and most of the systems in Canada.

RELIABILITY and ADEQUACY are separate but independent aspects of the bulk power supply system of the electric utility industry in North America. RELIABILITY involves the security of the interconnected transmission network and the avoidance of uncontrolled cascading tripouts which may result in widespread power outages. ADEQUACY refers to having sufficient generating capability at all times to be able to meet the aggregate electric peak loads of all customers and to supply all their electric energy requirements.

Mr. FUQUA. Thank you very much, Mr. Gent.

Mr. Winn.

Mr. WINN. Thank you. Mr. Chairman, Madam Chairman, members of the subcommittees, I am also very pleased to be here today to participate in this discussion of the integrity of the electric power systems.

In my written statement, I try to make certain points. Electric systems inherently do present exposure to damage of all kinds. But the interconnected bulk power system provides many alternative paths for the flow of power, as well as providing the capability of transferring emergency power from one electric system to another.

Also, all of the electric systems in this country have emergency plans already developed and in place to handle almost any emergency. These plans do need to be reviewed periodically and refined as necessary to keep them current and to assure that they adequately assess all potential problems. In my opinion, there are very limited options for improving the physical protection of electric systems, and the cost of any of these would need to be weighed very carefully against any increased protection.

Actually, as has been mentioned, the electric systems in this country have an excellent record of continuity of service. Last year, they delivered 2,311 billion kilowatt-hours of energy to their customers, and the amount of energy that was not supplied due to power failures was a very small fraction of 1 percent of that total. That is pretty remarkable, considering the exposure of the delivery system. Most of the interruptions, as has been mentioned, occur on distribution systems which are the lower voltage circuits that carry power to the individual consumer. These are the circuits that are vulnerable to weather, high winds, lightning, ice and snow. They are frequently built on streets or highway rights-of-way, and they are also very vulnerable to automobiles and trucks.

The bulk power system, consisting of a network of higher voltage lines that takes power from the generators to major load centers, is subject also to interruptions, but during the last year, these have been declining. Interruptions on this system are usually results of more severe problems, such as the multiple outages of transmission lines or generating units, or a combination of the two.

However, the exposure is there, and all electric power systems, by their very nature, are subject to possible damage and disruption from natural sources as well as deliberate actions.

Long ago, electric utilities found out that reliability of service could be improved and costs could be reduced by interconnecting these individual systems to form networks which allow them to provide emergency assistance to one another. This assistance can take the place of supplying power to a system that is having problems with generators, or the network can provide alternative paths for power flow when there are transmission lines out of service. The TVA system, with which I am involved, is a part of this much larger interconnected system which covers most of this country. The electric systems in other parts of the country are also parts of interconnections.

System studies are constantly being made by individual utilities, groups of utilities and regions, examining the reliability of the systems as they exist and as they are planned for the future. These

studies also explore how much power can be transferred from system to system or from one region to another under both normal and abnormal conditions.

These bulk power systems are designed to provide continuity of service in spite of forced outages of generating plants, major substations or transmission lines. However, things do happen.

In 1974, the TVA system, among others, was severely damaged by a series of tornadoes. In my written statement, I go into some detail in describing that occurrence.

About 14 years ago, the nine regional councils were created, and they make up the North American Electric Reliability Council. The creation of these regional councils was, in some respects, a response to the Northeast blackout of 1965, and also the perceived need to improve the reliability of the bulk power system through better coordination and planning.

It was recognized that widespread, cascading blackouts must be avoided in the future. So all of these regional councils have adopted reliability criteria which address the design and the simulated testing of bulk power transmission systems. The purpose of these criteria is to minimize the effect of even the more improbable, but conceivable, system disturbances, to minimize the area impacted by such disturbances, and to facilitate the speedy restoration of service in any area that might experience a blackout.

These criteria typically require the electric systems to examine the effects of the loss of the largest generating plant on the system, the loss of a major load center, the loss of all transmission lines on a common right-of-way, or the various combinations of outages of transmission lines and generators simultaneously.

It is entirely possible, as has been mentioned, that some severe damage can be done to power systems. Under these conditions, it is possible that parts of the system will become separated and form islands. This islanding is an acceptable response to extreme disturbances and is so recognized in most of the regional reliability criteria. In fact, it might be one way of preventing the uncontrolled spread of the disturbance. But to operate systems as islands normally would lose all of the benefits of interconnecting.

None of this is intended to imply that today's electric systems can withstand, without any adverse effects, damage that might be inflicted by those seeking to deliberately disrupt electric service. It does indicate that to deprive a large area of electric power, there would have to be a number of carefully planned and coordinated attacks on key facilities which might be located over a very wide area.

I would also here like to say that I share the concern expressed in Mr. Gent's and Mr. Iveson's statements that some transmission lines which are needed today to improve reliability are not, for one reason or another, being constructed.

It is recognized in the industry that 100 percent continuity of service cannot be insured. The industry has always worked with hospitals, local law enforcement and emergency planning authorities, the communications industry and others to assist in establishing the level of onsite backup generation which would be required to maintain these essential services.

Also, all power systems have emergency plans for various types of system problems. For example, TVA has a number of plans which assign responsibilities and direct the actions to be taken for the restoration of the system following damage from sleet, earthquakes, tornadoes, or enemy attack. We have other plans that provide for emergency load reductions, that provide information on available spare equipment and routes for moving this equipment as necessary, and for the evacuation of certain of our key facilities. Since the prevention of damage to the system from almost any cause is nearly impossible, emphasis is placed on minimizing the effect of the damage and the prompt restoration of service.

TVA has also established a transmission emergency control center with all of the necessary communication equipment to assist our field people in the rapid restoration of service in cases of natural disasters or other emergencies. We have available a trained task force to staff this center whenever required.

Dr. Berger mentioned the stockpiling of various pieces of electrical equipment, such as transformers, circuit breakers, and transmission lines, with the idea that these could minimize the length of outages caused by damaged equipment. This is certainly true. But although all systems do carry an inventory of spares for their system, the magnitude or the extent of the inventory is based on the normal failure rate of such equipment. It is very expensive to maintain even a normal inventory of spare equipment for generating plants and the transmission system.

At the present time, the value of the spare equipment on the TVA system amounts to more than $250 million. We have implemented a computerized control system to try to reduce this inventory because of the expense of maintaining it. There are, and always have been, very cooperative efforts in the industry to take advantage of the cooperative use of spare equipment which can be used on more than one system. But again, this stems from an effort to reduce costs and not as a method of increasing the inventory of spare equipment.

Stockpiling material for transmission line repairs is not too much of a problem. It is not as costly and utilities normally have spare towers, insulators, wire, and whatever is needed to put lines back up again after they have been damaged.

We have also heard about dispersed generating sources. TVA's policy on small dispersed generating sources is one of very positive support. We have several programs actively encouraging the development of these dispersed sources in the valley, and these are described briefly in my written statement.

We do not see any particular problem in these sources being connected to the power system as long as the connection is made in such a manner as to adequately protect both the small generator and the power system. At the present time, the total of all of those sources on our system is small compared to our generating capacity, but even with the maximum development that we foresee, we do not anticipate any significant problems.

Some of these facilities, we believe, would be connected to local loads as well as to the power system and, therefore, in case of the disruption of the power system, these sources could remain connected to the local loads and continue to supply them.

As to the appropriate Federal role, I believe that it should be to concern itself with emergencies of a national scope through the Federal Emergency Management Agency and Mr. Vaughan's organization in the Department of Energy. These have been given responsibilities in dealing with such emergencies. It should establish before the fact policies and guidelines within which the States and the utilities could develop ccordinated emergency plans. To insure that national priorities are met, the appropriate Federal agencies should work with the States to determine the priorities for loads to be served in case there are emergencies which require some curtailment of load. The electric industry could then take this into consideration in its planning.

I believe that decisions as to the actual steps to be undertaken by a utility during an emergency and in the restoration of the electric system can only be effectively made by those having actual knowledge of the system's capabilities and experience in dealing with such emergencies, and these are the operators of the particular system. Such background and knowledge are essential in light of the varying and unique circumstances that usually face individual systems during such emergencies.

Thank you.

[The prepared statement of Mr. Winn follows:]

STATEMENT OF

CHARLES E. WINN, SENIOR POWER ENGINEER

TENNESSEE VALLEY AUTHORITY

BEFORE THE

SUBCOMMITTEE ON ENERGY DEVELOPMENT AND APPLICATIONS

AND THE

SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION

COMMITTEE ON SCIENCE AND TECHNOLOGY

UNITED STATES HOUSE OF REPRESENTATIVES

DECEMBER 9, 1982

I am very pleased to be here today to discuss the "Integrity of Electric Power Systems." Many of my comments will be based on the TVA system experience. But what is true for the TVA system is generally true throughout the electrical industry.

The electric systems in this country have an excellent record of continuity of service. Last year they delivered 2,311 billion kilowatthours of energy to these customers--the total amount of electical energy used in the United States during 1981. The amount not delivered to the consumer because of power failures was a small fraction of 1 percent of that total. This is really remarkable, considering the exposure of the overall delivery system. Most of the interruptions of service to individual customers are due to problems on the distribution system--the lower voltage circuits which carry power to the individual consumer. These circuits are particularly vulnerable to adverse weather conditions--high winds, lightning, ice, and snow. Distribution lines are frequently built on highway and street rights of way, and are subject to damage from automobiles and trucks.

The bulk power system, known as the transmission system, is made up of high-voltage lines carrying power from the generating plants to large load centers. There are interruptions of service caused by disturbances on this system, but their frequency has been declining. These interruptions are usually the result of much more severe problems, such as multiple outages of transmission lines, or generating units, or a combination of the two.

The exposure is there, and all electric power systems are, by their very nature, subject to possible damage and disruption from natural forces, as well as deliberate actions.

Long ago, electric utilities found out that reliability of service could be improved and costs reduced by interconnecting their individual systems to form networks which would allow them to provide emergency assistance to each other. This assistance can be supplying power to a system when some of its generation is out of service or providing alternate paths for power flow when one system has transmission lines out of service. The TVA transmission system is part of this much larger, interconnected system of electrical transmission covering most of the eastern and central part of the United States and parts of Canada. The principal purpose of this interconnected network is to provide reliability and continued service in the event of an outage of any part of that network. System studies are

constantly being made by individual utilities, groups of utilities, and regions, examining the reliability of the systems as they exist and as they are planned for the future. These studies also explore how much power can be transferred from system to system or from region to region under normal and abnormal conditions.

Systems are designed to provide continuity of service in spite of forced outages of generating plants, major substations, or transmission lines. These events do occur, either through accident, breakdown of equipment, or severe weather.

As an example, in April 1974 the TVA system (among others) was severely damaged by a series of tornadoes. These started during the evening of April 1 and caused the loss of nine 161,000-volt transmission lines. The tornadoes increased in frequency on April 3, and by the morning of the 4th, ten 500,000-volt, twenty-six 161,000-volt, and thirty-four lower voltage lines were out of service. Seventy-five substations were out of service for various lengths of time. Electric loads totaling 800,000 kilowatts were out at one time or another. All six of the 500-kV lines from the Browns Ferry Nuclear Plant were damaged, isolating the plant from the system.

Our operating people followed the emergency disaster plan which has been developed for this type of contingency and which provided an orderly plan of recovery. Our area maintenance forces were augmented by all available

construction crews, and emergency repairs were completed by April 7, 1974, allowing all loads to again be served. System operating conditions were carried out under extreme emergency conditions during the week of April 7-14; but our interconnections held, and we obtained assistance from other power companies. Most of the damaged lines were back in service within a month, but the system was not completely back to normal for six months.

Some years ago, the nine regional councils were created constituting the North American Electric Reliability Council. This was, in some respects, a response to the Northeast blackout of 1965 and the need to improve the reliability of the bulk power network through better coordination and planning. Recognizing that widespread, cascading blackouts must be avoided in the future, all regional councils adopted reliability criteria addressing the design and simulated testing of the bulk power transmission systems. The purpose of these criteria is to minimize the effect of even the more improbable, but conceivable, system disturbances, to minimize the area impacted by such disturbances, and to facilitate the speedy restoration of service in an area that might experience a blackout. These criteria typically require the electric systems to examine the effects of extreme disturbances such as the loss of the largest generating plant, the loss of a major load center, the loss of all transmission lines on a common right of way, and various combinations of the loss of multiple lines and generators simultaneously. The criteria recognize the impossibility of studying every possible combination of outages. But if a system can demonstrate its ability to meet the stated criteria, it can probably withstand other serious disturbances not studied.

It is entirely possible that severe multiple outages will cause system separations and that part of the system may become entirely separated and form an "island." This islanding is an acceptable response to extreme disturbances and is recognized in most of the regional reliability criteria. In fact, it may be one way of preventing the further uncontrolled spread of the disturbance. Within the island there would probably be an unbalance of load and generation. If there is more generation than load, automatic controls would reduce generation to match the load. If there is too much load, the frequency will decline; and automatic underfrequency load-shedding relays will operate to reduce the total load to a value equal to the available generation. It is for this purpose that electric systems have installed these relays, which can reduce the load in a given area by 30 to 50 percent, depending on the magnitude of the frequency decline. This keeps generating units running and on the line, contributing greatly to the prompt restoration of the interconnected network and the restoration of service to customers.

This is certainly not intended to imply that today's electric systems can withstand, without adverse effects, the damage that might be inflicted by those seeking to deliberately disrupt electric service. It does indicate that, to deprive a large area of electric power, there would have to be a

number of carefully planned and coordinated attacks on key facilities located over a wide area.

Although an attack on certain bulk power facilities could reduce the power supply capability to the extent that the total load could not be supplied, it would generally be possible to use local sources and lower voltage transmission lines to supply essential loads. Some rearrangement of the system might be required and some switching might be necessary, but this is the sort of thing that operating personnel are trained to do. It would not be so different from the restoration procedures required to restore service after weather-related outages. These types of outages occur fairly frequently now, and recovery is usually achieved after a short period of time.

In January of this year an ice storm occurred in a neighboring State, which resulted in some 250,000 customers being without electric service. Most of the damage was from trees falling into distribution circuits. Even with the assistance of repair crews from other utilities, it was a week before all service was restored.

It is recognized in the industry that 100 percent continuity of service cannot be ensured, as illustrated by this example. The industry has always worked with hospitals, local law enforcement and emergency planning authorities, the communications industry, and others to assist in establishing the level of onsite, backup generation required to maintain these essential services.

We have been very fortunate in this country in that it has not been necessary to plan for all of the emergencies that we are considering here today, particularly those deliberate actions taken to disrupt service. In fact, some developments in the industry, which have been motivated by economics--supplying power at the lowest cost--have been in the direction of greater vulnerability. The size of individual generating units has increased to capture the economy of scale, higher transmission voltages have been achieved so that more power can be carried over a single circuit; larger substations have been constructed to serve larger areas, transmission lines have been squeezed into corridors to utilize the minimum amount of right of way, and more and more substations are operated by automated supervisory control with no operators on duty at the substations. Although these changes have taken place with due consideration of reliability criteria and do not reduce the level of reliability for the more probable system disturbances, they still tend to increase, to some extent, the vulnerability of the systems to some types of damage.

All power systems have emergency plans for various types of system problems. For example, TVA has a number of plans which assign responsibilities and direct the actions to be taken for the restoration of the system following damage from sleet, earthquakes, tornadoes, or enemy attack. Other plans provide for emergency load reductions, provide information on spare equipment and plans for moving this equipment, plan for getting emergency power to major generating plants from hydro sources

to facilitate restart, and provide for emergency evacuation of certain facilities. These plans are put into effect for minor system problems, as well as for such emergencies as massive simultaneous loss of generation, massive destruction of transmission lines by natural or other forces, or a lack of fuel for generation. Since the prevention of damage to the system from almost any cause is nearly impossible, emphasis is placed on minimizing the effect of the damage and the prompt restosation of service.

TVA has also established a transmission emergency control center with the communication equipment to assist in the rapid restoration of service in cases of natural disasters or other emergencies. A trained task force has been chosen to staff this center when required.

It has been suggested that the stockpiling of various pieces of electrical equipment, such as transformers, circuit breakers, and transmission line material, could minimize the length of outages caused by damaged equipment. Although all systems carry an inventory of spare equipment and usually have spare transformers on site in substations, the extent of this inventory is based on the normal failure rate of such equipment. It is very expensive to maintain a normal inventory of spare equipment for generating plants and the transmission system. TVA has implemented a computerized control system to reduce its inventory, now valued at more than $250 million in total. This should reduce inventory as well as cost. The problem and the cost of maintaining an even greater number of spares are complicated by the variety of equipment needed. Although TVA has standardized on a certain

size of large transformer bank for 500-161-kV substations, they are not all identical. The same is largely true of circuit breakers. There are, however, efforts currently underway in the industry to take advantage of the cooperative use of spare equipment which can be used on more than one system. But again, this is an effort to reduce costs, not to increase the inventory of spare equipment available.

Stockpiling material for transmission line repairs is not as much of a problem. Utilities normally have available spare towers, insulators, and wire. Materials from lines under construction can be and have been used for emergency repairs.

I am aware of the interest in examining the feasibility of dispersed generation sources in mitigating the effects of outages on the power system. TVA's policy on small dispersed generation sources is one of positive support. There are several programs actively encouraging the development of these dispersed sources in the Valley. We presently have 95,675 kW of cogeneration connected to the system and are working with all potential cogenerators--both existing industries and those industries seeking to locate in our service area.

TVA has participated in the construction of the Sumner County Resource Recovery Facility at Gallatin, Tennessee, where municipal waste is burned to supply steam to three industries, and to a small electric generator which is connected to the TVA system. We are continuing the testing of this facility while working with several other municipalities in investigating the feasibility of this type of energy source.

We have made a survey of all the small dams existing in the area and have examined them for the feasibility of installing or reinstalling hydro generators. We are actively carrying on research in fuel cells, using various fuels which are available in the Valley or which might be available in the future. We are using photovoltaics in several remote locations and are participating in the Federal Photovoltaic Utilization Program. We are also doing research on wind machines and the effects of connecting them on the power system.

We do not see any particular problem in these sources being connected to the power system as long as the connection is made in such a manner as to adequately protect both the small generator and the power system. At the present time, the total of all those sources is small compared to our total generating capacity. Even with the maximum development that we foresee, we do not anticipate significant problems. But this also means that the total effect of these sources on the power supply for the Valley is small. Some of these facilities will be connected to local loads as well as to the power system and could be of value in supplying these loads in the event of outages of the power system, just like other onsite backup power sources. During outages of the power system, these dispersed sources should be automatically disconnected from the system for the protection of both the small source and the TVA system.

I am aware of the interest in establishing the role that the Federal Government should play in maintaining the integrity of electric systems.

I believe the appropriate Federal role would be to concern itself with emergencies of a national scope through the Federal Emergency Management Agency and the Emergency Preparedness organization in the Department of Energy, which have been given responsibilities in dealing with such emergencies. It should establish "before the fact" policies and guidelines within which the States and the utilities could develop coordinated emergency plans. To ensure that national priorities are met, the appropriate Federal agencies should work with the States to determine priorities for loads to be served in case of emergencies which require some curtailment of load. The electric industry could then take these into consideration in its planning for all types of emergencies requiring curtailment of load.

Where a regional approach is necessary, as where emergency planning should be done on a regional basis, the Federal Government should assist the States in arriving at coordinated emergency plans.

Decisions as to the actual steps to be undertaken by a utility during an emergency and in the restoration of the electric system can only be effectively made by those having actual knowledge of the system's capabilities and experience in dealing with emergencies--the operators of the particular system. Such background and knowledge are essential in light of the varying and unique circumstances that usually face individual systems during any such emergency.

Mr. FUQUA. Thank you very much, Mr. Winn.

Mr. Iveson.

Mr. IVESON. Thank you.

Mr. Chairman and Madam Chairman, I, too, shall not spend much time. I will only emphasize the parts of the written material which I feel are relevant to this committee.

The R&D aspects of the request address themselves to control. At this point, although that aspect is important and there is research underway, I think we need to emphasize that no amount of control will replace the need for actual facilities.

In item two, new materials and new equipment, my written material may seem to be rather light on that. But I think we have to realize that there are millions of items out there now and no amount of new material or new equipment can impact on reliability until it is out there and installed. I think you understand that many of those items are expensive. So for new materials and new equipment to have an impact, it will require a long time.

No. 3, solar and wind machines. In the same way, these are expected to be small and dispersed. In order to have a large impact, it will require many, many years before they can have any substantial impact. Again, R&D is being carried on to determine how to model them and how to understand what their influence on reliability may be.

The last of the four items, islands, I share Mr. Winn's viewpoint. In the analysis that we have made, it is better to be a whole to begin with and break up into a piece or a part after the disturbance is underway. In that way, you gain the advantages and they are very real, for all the hours that you are not in a disturbance.

I have one last point. Our research at EPRI is utility funded. We had looked to DOE to provide research in areas that were more high risk. That support at this point has been reduced and, with the utility industry financially in the state it is in, I doubt that there will be a significant additional support for that (high risk) R&D which is not being done now in that group—DOE.

I would like to conclude by saying that there is a relationship between the financial health of the utilities and reliability. To the degree that they are allowed to earn a reasonable rate of return, we should be able to maintain the levels of reliability which have been historical.

That concludes my material. If there are any questions I may help with, I will be glad to respond to them. Thank you.

[The prepared statement of Mr. Iveson follows:]

TESTIMONY OF ROBERT H. IVESON

Program Manager, Power System Planning & Operations

Electrical Systems Division

Electric Power Research Institute

Before

Subcommittees on Energy Development &

Applications and Energy Research & Production

of the Committee on Science and Technology

U. S. House of Representatives

Washington, D.C.

December 9, 1982

Mr. Chairman:

Good morning. I am Robert H. Iveson, Program Manager of the Power System Planning and Operations (PSPO) Program in the Electrical Systems Division of the Electric Power Research Institute (EPRI), Palo Alto, California. On behalf of EPRI, I would like to thank you for the opportunity to appear before these Committees and present information on the Integrity of Electric Power Systems.

This testimony is in response to your invitation to me of November 23, 1982. I will present a short summary of my official testimony and am prepared to respond to questions from the Committees as well as participate in discussions between the other witnesses who are appearing before the Committees. I joined EPRI in 1979 in the position which I currently hold. I am currently responsible for R&D efforts in the areas of bulk power system planning and bulk

power system operations. Prior to joining EPRI, I worked in the electric utility industry for almost 20 years. The first 12 were in areas of increasing responsibility in generation and transmission planning. The last 8 years were spent with a major Power Pool with the dual responsibilities of transmission planning and operations support. This included establishing safe operating levels for day-to-day system operation. During my career I have had direct involvement in the analysis of a large number of system disturbances. These include the Northeast blackouts of November 9, 1965 and July 13/14, 1977. Therefore, my testimony, while directed toward the R&D aspects of system integrity, carries with it the background of practical experience in both planning and operations.

My testimony will address levels of integrity and the potential for strengthening electric energy systems. The several topic areas suggested in the invitation are each relevant. However, a brief general discussion of the factors affecting levels of integrity will help to place the topics in perspective and identify other factors relevant to the integrity of power systems.

CURRENT LEVELS OF INTEGRITY

Bulk power systems are designed, as a minimum, to sustain the loss of a major component at peak load. It is not unusual, however, for particular systems to apply more stringent criteria. In those areas requiring higher levels of reliability, the additional expense must be justified either on the basis of cost or societal impact.

The number of generating plants and/or transmission lines supplying a major area may range from 3 to 10, and during lighter load periods, it may be possible to sustain the outage of several of these plants and lines at the same time. In providing multiple supplies to an area, consideration is given to route diversity, risk of physical hazard, weather, environmental concerns, and a host of other factors.

It is important to realize that reliability depends upon the financial health of the utility. For example, the reduction of maintenance budgets may threaten reliability at a future date. The industry today is experiencing serious financial difficulty. There is a danger that previous levels of reliability cannot be maintained if this condition continues.

RELIABILITY VIEWED SIMPLY

When a power system is operating in a normal condition, there is a continuous balance between the load being served and the generation supplying it. There is also reserve capacity in both the generation and transmission systems to withstand the shock of loss of facilities.

What are the significant factors in a major system upset? Really only one. That is, as a result of one or more events, the system experiences an imbalance of load and generation from which it cannot recover via its own natural forces.

Examples of such events are: the unexpected outage of lines or

generators; a slowly evolving supply deficiency; a catastrophic event such as a hurricane or earthquake, and many, many others.

In order to improve system integrity, therefore, we seek ways to maintain and restore the balance of generation and load before, during, and after disturbances.

This rather simple set of statements establishes a framework to consider the seven topic areas we have been asked to address as well as others.

1. REQUIRED RESEARCH IN POWER SYSTEMS CONTROL

There are several ways in which system control can improve system integrity and increase system strength. The best example follows: improve methods to obtain data on present system conditions; conduct a "what if" analysis by evaluating the impact of postulated contingencies; rank the severity of the possible contingencies; and suggest actions the operator can take to maneuver the system to a more secure state.

Such methods are available today in a rudimentary form. But they are so expensive and relatively slow that only 13 utilities on the North American continent presently have them. Further, the techniques are too slow to analyze contingencies involving the rapidly cascading type of events that are frequently associated with major upsets. The slowness of present analytic capabilities

precludes the opportunity to take corrective action except for such measures as customer interruption.

The controls and techniques existing today are technically difficult, expensive to install and maintain, subject to misoperation and perceived to have infrequent use. These perceptions are valid, and suggest that R&D effort should be dedicated toward reducing cost and improving their performance.

As we move toward the early 1990's with anticipated shortages of generation and with transmission systems loaded ever more heavily, the R&D to develop new controls with greater speed, accuracy, and analytic capabilities cannot come too soon. In the final analysis, control equipment cannot substitute for the generation and transmission facilities needed to supply customers. It can, however, assure that those facilities available are used in the most effective manner.

In system control, the topic described above is called "contingency or security analysis". It is only one of several areas of needed research in power systems control. Others, including system control analysis and loss evaluation can only be mentioned briefly in the space and time available in this forum.

It has been said that space vehicles have only become successful after computers of sufficient power and speed were developed to guide them. In a similar sense, the power system that drives our

country's economy seems worthy of a control system adequate to maintain its integrity.

2. NEW MATERIALS AND NEW EQUIPMENT WHICH COULD MAKE ELECTRIC ENERGY SYSTEMS LESS VULNERABLE

Returning to the basic mechanisms of system failure, it is clear that both new materials and equipment can be exploited to improve system integrity.

New materials which reduce equipment failure due to physical or electrical factors will improve system reliability. Analysis of system disturbances shows that materials such as insulating materials and metals play a continuing role in equipment failures which trigger upsets. Efforts are underway to improve performance of existing materials and to develop new materials where existing ones do not perform in an acceptable manner.

3. IMPACT OF USING VARIOUS DISPERSED SYSTEMS SUCH AS SOLAR PHOTOVOLTAIC, FUEL CELLS, AND WIND MACHINES

The impact of solar and wind devices on system integrity will be dependent on the character of their installation and the proportion of total system capacity that these devices represent. Both solar and wind are fluctuating sources, affected by minute-by-minute, hourly, daily, and seasonal variations. These sources are unlike

the traditional fossil-fired or hydro-driven generators which operate at constant output for many days at a time. Thus solar and wind can be expected to operate reliably only with some form of storage device. These devices will smooth the short term fluctuations which are of concern to system control engineers. Much work remains to be done to achieve solar and wind systems with storage and control equipment which are economically feasible.

Solar and wind also have seasonal characteristics which may not match seasonal peak loads. It is possible that systems with such sources will require installed generation reserves greater than those associated with traditional sources. Technical analysis is required to resolve these problems on a utility-specific basis. With their high cost and fluctuating output, even in the long range, one should not expect significant improvements in system reliability from solar and wind.

Fuel cells are closer in performance to traditional generators because of their base load capabilities. They have the additional advantages of small size, rapid start-up capability, relatively short installation times (2 years), and potential fuel efficiencies better than present-day large generators. The present disadvantage of use of oil and gas as a fuel can be eliminated by use of on-site coal gasification where suitable. Fuel cells represent a significant potential for improving system security in those areas where they can be properly applied.

4. THE "ISLAND CONCEPT"

The "island concept" can be interpreted in two ways. One is that

the present system of interconnected entities should be permanently disconnected and operated as a series of independent groups. This is not the case today. The second is usually called the "islanding" concept. It involves installation of devices and controls to intentionally separate one power system from others during severe disturbances so as to prevent cascading events. It is reasonable to speak to both interpretations. Permanently independent groups is, of course, the configuration from which the present-day interconnections evolved. In the early 1900's, it became apparent that the cost of spare parts and the time to install them after a failure occurred could be reduced if connections could be made from one company's facilities to the one suffering the outage. These connections were frequently temporary and relatively weak.

But as systems grew, it became evident that both cost savings and improved reliability were possible by interconnections. Interconnecting, however, carries with it a responsiblity for a high level of communication and control. It is true that the lack of an adequate level of communication and control has contributed to system upsets. This was spoken to in item 1 above.

To return to independent operation, however, is the wrong direction. Based on the history of the industry, it would result in both higher consumer costs and a reduction in system integrity and strength. There is an opportunity to combine both concepts as has been done and is being done today in the industry. Most systems study the performance of their systems under a variety of contingencies. Based

on these analyses, utilities determine the location and settings for protective devices which separate the impaired portion of the system and thereby prevent cascading events. There are dozens of examples of such installations and their successful operation is a matter of record (1).

The concept of "islanding in a pre-determined manner following a severe disturbance" is the recognized method of balancing system reliability against cost. No system can be built to sustain every possible contingency. Flexibility and resiliency can be achieved by islanding schemes.

It is true that work to improve the analytical power system models is ongoing. Current research efforts are addressing improved models of the various components of large systems and their interaction during disturbances lasting several minutes.

5. ANY NECESSARY CHANGES IN OPERATING PROCEDURES

This area will be addressed primarily by other witnesses. It is appropriate to point out, however, that as system changes occur as a result of items 1-4 above, corresponding changes may be required in operating procedures. The manner in which dispersed generation can best be monitored and dispatched is still under study. In the absence of low cost monitoring and communication equipment, some form of mathematical estimation will be required to synthesize the status of large numbers of the devices.

Reflecting on the "island concept" just discussed, there is an operating procedure used during imminent storm threat periods which combines both concepts. It involves reducing a company's power interchange to zero. This places the system in a condition so that even if all ties are lost, the system experiences no deficiency. It does increase the cost of operation for the period of zero interchange (since it is assumed either a positive or negative interchange was economically beneficial). Experience shows that the cost of relatively few hours of operations per year in this mode is far outweighed by the improvement in system security during these high risk periods.

6. ADDITIONAL PHYSICAL SECURITY

There is the common sense approach that reasonable attempts at physical security should be balanced with power system design and operations which anticipate any number of possibilities, including hostile action to intentionally cause system failure.

I believe other witnesses will speak to this issue.

7. THE SHORTCOMINGS THAT MIGHT BE EVIDENT IN INTER-GOVERNMENTAL AS WELL AS INSTITUTIONAL RELATIONS DURING AN EMERGENCY ESPECIALLY IF MORE THAN ONE NETWORK IS INVOLVED.

This issue is extremely important and not strongly related to R&D. My previous utility experience has repeatedly demonstrated that

power system emergencies also test the adequacy of inter-governmental and institutional relations. Invariably the people directly involved in restoration of the system and analyzing the causes of the disturbance are also required to interface with a variety of government, citizen, and media entities. The success of these efforts has improved, but more effort is required to 1) establish the necessary lines of communications before the events, 2) identify the responsible spokesmen and their alternates prior to the events, 3) prioritize access to critical personnel so that restoration of the system and determination of the cause of the disturbance are not hampered by regulatory responses and media appearances, 4) balance the need to keep the public informed in a quiet and effective manner with the need to restore service as rapidly as possible.

These goals require continuous planning and action on the part of all parties. Unfortunately, during periods of economic distress, these activities are the first ones to be curtailed or eliminated and this at the time when the same economic factors may increase the likelihood of system upsets.

As in all real world circumstances, there is no single answer.

A SUMMARY

In summary, there is a wide range of actions that can be taken to improve the integrity and strength of the electric energy systems.(2) Many of these are already being carried on within existing capabilities.

There are opportunities within current R&D efforts to improve upon those existing capabilities. Those items responded to directly in this testimony are important. However, the scope of these hearings is not sufficient to address the entire range of concerns. Parts of the problems have been studied and documented in a number of reports and papers published by EPRI, DOE, and other agencies (2). An organized ranking and summary of current recommendations as an outgrowth of these hearings is indicated. The result would provide the Committees an assessment of the greatest impact on system integrity per dollar spent for both the existing system changes and in R&D.

Again I appreciate this opportunity to present these thoughts. I trust they will be helpful in resolving a problem that involves the very backbone of our nation's well-being. Thank you.

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BIOGRAPHICAL SKETCH OF ROBERT H. IVESON

Mr. Iveson joined the Electric Power Research Institute (EPRI) in 1979 as Program Manager of the Power System Planning & Operations Program. The Institute is a non-profit organization which plans and manages research and development on behalf of the U.S. electric utility industry and the public.

Prior to joining EPRI, Mr. Iveson served from 1971 to 1979 as Supervisor of Transmission Planning at the New York Power Pool (on assignment from New York State Electric & Gas Corp.) with the dual responsibilities of transmission planning and day-to-day operations support.

Prior to 1971, he worked for New York State Electric and Gas Corp. He held positions of increasing responsibility leading to Supervisor of Transmission & Interconnection Planning prior to accepting the assignment at the New York Power Pool.

He holds degrees in electrical engineering from Rensselaer Polytechnic Institute and Syracuse University. He has authored several technical papers and is a member of several professional and honor societies.

12/6/82

Mrs. BOUQUARD [presiding]. Thank you very much, Mr. Iveson.

I would like to recognize Mr. Volkmer at this time if he has any remarks he would like to make.

Mr. VOLKMER. I am sorry I wasn't here earlier for some of the testimony. I would just say that I have just had time here to review some of the testimony.

According to what we know so far, the electrical power system is fairly reliable. In layman's language, would you put it that way—with what we have and the knowledge that we have presently?

Mr. VAUGHAN. Yes.

Dr. BERGER. Yes.

Mr. WINN. Yes.

Mr. GENT. Yes.

Mr. IVESON. Yes.

Mr. VOLKMER. And we are not apt to see such as occurred several years ago, such as the blackout in New York; would I be fair in saying that or not?

Mr. GENT. Mr. Volkmer, our whole organization was created after that 1965 blackout. Most of us here at this table are dedicated to assure that that will never happen again.

Mr. VOLKMER. Can you assure me that that type of thing would probably not happen again?

Mr. GENT. I am glad you put the probably in there.

Mr. VOLKMER. I mean outside of an outside force.

Mr. GENT. Yes, sir. Technology has also gone a long way since then.

Mr. VOLKMER. You have the capability of wheeling this power around and moving it around?

Mr. GENT. Yes, sir, particularly with what we call underfrequency relays that actually allow us to break up and put the system back together. That is one of our most recent advancements.

Mr. VOLKMER. So if, for some reason or another—let's go back to TVA—if, for some reason or another, some of your power generating capacity—let's say your plants would all go down at one time, or half of them or a third of them, would you be able to obtain power elsewhere within a short period of time?

Mr. WINN. If as much as a half of our generating capacity were out at one time, it would be very difficult for us to import enough power from other sources to carry our entire load. We have had experiences in past years where we have been in the position of having to import up to, say, 3,000 megawatts, which is a pretty good fraction of our total capability, in order to carry the load.

But with of the diversity of outside power sources that Mr. Gent was referring to and the fact that our generating capacity is dispered, and that it is hydro, coal-fired, and nuclear, it is very unlikely that we would have such a large number units off the system at any one time.

Mr. VOLKMER. As I was going through the testimony, back not too many years ago, you did have quite a bit of tornado damage in the TVA system at one time.

Mr. WINN. Yes, sir, in 1974.

Mr. VOLKMER. Right. Let me ask you in that regard if there was any activity of DOE or any governmental agency in assisting you to get that back together, or was it purely your operation?

Mr. WINN. As far as I know, it was purely our operation, yes, sir

Mr. VOLKMER. Mr. Vaughan, reading what happened just recently in Hawaii, is it DOE's responsibility only to provide maybe advice if someone needs it? We have no actual program in the event of an emergency, do we?

Mr. VAUGHAN. Congressman, as I indicated in my testimony, the primary Federal responsibility in a civil emergency rests with the Federal Emergency Management Agency. They were immediately involved in the Hawaiian situation. I think the record indicates that essential public services were very quickly restored in Hawaii, and I think that is really a success story.

We were involved in monitoring. We were ready to render assistance if requested. We were not so requested by either the State of Hawaii or FEMA. But we were in contact with both ready to provide whatever assistance if they were to request it.

Mr. VOLKMER. As far as the area of providing electrical need—I don't know if you would know this, and maybe I should ask FEMA—but what would FEMA be doing as far as that is concerned?

Mr. VAUGHAN. FEMA was on the scene to help arrange such things as bringing in the generators from the Navy or helping the two power companies—I believe there were two power companies involved. FEMA has broader responsibilities into general disaster relief, so they were also involved with all of the hospitalization, restoration of police services and that sort of restoration.

Mr. VOLKMER. In other words, they would be involved in obtaining portable generators and things like that?

Mr. VAUGHAN. That is correct.

Mr. VOLKMER. But not actually in working with utilities and putting back the power operation and lines and things like that?

Mr. VAUGHAN. There is no Federal agency, Congressman, that has electricians and that sort of thing that go there to assist. The utilities have that themselves, and they pool those resources when one of them or several of them encounter a difficulty.

Mr. VOLKMER. So if you have a disaster, you can anticipate that they would come from all over the area and from different areas to help out?

Mr. VAUGHAN. That is absolutely correct, Congressman. I remember several years ago when I was a resident of Michigan we had severe ice storms and there were repair crews assisting Detroit-Edison from 500 miles away. These were from private investor-owned utilities.

Mr. VOLKMER. Is it true that basically we are looking at the private industry taking care of this problem, not government, whether State, local, or Federal to any degree; is that correct?

Mr. GENT. Yes, Congressman. In fact, we are kind of looking for the problem. What you are looking into are events that we have taken care of over the years, as Mr. Vaughan has indicated, such as hurricanes, tornadoes. There have actually been, as I understand it from a paper I read recently, some 20 acts of terrorism and sabotage, all of which have been withstood. We are working with

Secretary Vaughan assuring that plans are in place to handle virtually any contingency that can be conceived.

Mr. VOLKMER. Any type of natural disaster; is that what we are talking about? How about manmade?

Mr. GENT. I think we have conceded that electric utilities have adequately in the past handled natural disasters.

Mr. VOLKMER. Right.

Mr. GENT. The Department of Energy's chief concern for the last several years has been sabotage, terrorism, and acts of war. We have worked as an industry very closely with Secretary Vaughan's group to develop plans and methods of having industry and government interface, if necessary, to handle these situations.

Mr. VOLKMER. If somebody has touched on this, I missed it, but do you see any need to stockpile such things as large transformers for substations or anything like that?

Mr. GENT. This would have to be a personal statement. There are some—I can't identify them—it has been suggested to me that there are some in the electric utility industry that suggest that we need to do this. It is my personal opinion that it is far too costly and would be totally unsuccessful because of the variances in the different types of equipment.

What we do right now is we have in our pool, in our coordinating groups, in our councils, lists of telephone numbers, just a simple telephone number of a person in each utility that knows what his utility has, so that rather than have equipment stockpiled all over the country, we have the names of people who know where that equipment is. It takes just a simple telephone call.

Mr. VOLKMER. And you are satisfied that there is sufficient surplus ready and available equipment somewhere in the United States to handle the disasters that are contemplated?

Mr. GENT. Yes, sir.

Mr. VOLKMER. I have no further questions.

Mrs. BOUQUARD. Thank you very much.

Mr. VOLKMER. Dr. Berger, did you want to address that?

Dr. BERGER. Yes; I would like to comment on that. I might disagree in one area. In our studies, we have found that, as I have mentioned earlier, each utility's capability to respond to a disruption is different and the amount of the material that they have stockpiled is different. We have found some utilities that serve as key installations that do not have spare parts necessary to respond to a major disruption.

Mr. VOLKMER. There we are talking about an event involving outside interference?

Dr. BERGER. Yes.

Mr. VOLKMER. And talking there about a strategic military area, right?

Dr. BERGER. Yes.

Mr. VOLKMER. And the need to provide electrical energy to that.

Dr. BERGER. That is correct.

Mr. VOLKMER. Mr. Gent, your answer would basically be that if it isn't there, it is somewhere else?

Mr. GENT. That is correct. I don't think his studies have considered their ability to get hold of and cooperate with other electric utilities. I think you referred to the utility itself.

Mr. VOLKMER. That is correct.

Dr. BERGER. The information we obtained from the utility indicated, in this one particular instance, that they could not get spare parts for a minimum of 30 days.

Mr. VOLKMER. That is a pretty long time to have an installation out.

Mr. VAUGHAN. Congressman, if I might add something to that, I think what you are hearing here from both witnesses is factually correct. The very purpose of these studies that Dr. Berger was asked to do was to identify problem areas if they exist. I think that, at the same time, it is factually correct that the electic utility industry, both public and private, in this country have, when you look at it from a national perspective, a significant investment in spare equipment.

There is one other factor that I think has to be taken into account in dealing with electricity. You can jury rig equipment. So while it may be true that this specific utility referred to cannot receive the exact replacement piece of equipment, it can restore service with some sort of jury-rigged equipment that will do the job. There are very few instances when that cannot be done. I think these utilities are, from our studies at least today—we certainly believe that even in defense installations where there were purposeful and planned disruptions, the vast majority of them, we would be able to restore ideal service quickly and sufficient service very rapidly.

I would also point out that you do have the option when you cannot go back to full service of shedding nonessential load. Through the combination of restoring some portion of service and shedding nonessential load, it seems to me virtually any of our facilities can be put very rapidly back into operation. Our history with natural disasters indicates that that happened.

Mr. VOLKMER. Yes, Mr. Winn.

Mr. WINN. May I comment on that?

Mr. VOLKMER. Yes.

Mr. WINN. With reference to the tornado damage that the TVA system experienced—which I think is about the worst thing that ever happened to it—we jury rigged and made the necessary arrangements so that our entire load was picked up again within 3 days, although it took us 6 months to actually completely rebuild all of the transmission lines that had been destroyed.

Mr. VOLKMER. Within that 3 days, were all of your customers restored?

Mr. WINN. Yes, sir.

Mr. VOLKMER. But then what you did wasn't the most proper way to do it, so it took 6 months to actually go back and correct that.

Mr. WINN. To go back and rebuild and eliminate the jury rigging and that sort of thing, yes, sir, it takes quite a while sometimes to do that.

Mr. VOLKMER. I still have some concerns about what Dr. Berger has testified to and what he has said here. Maybe we can look into that further. I don't think it will hurt anything.

Thank you.

Mrs. BOUQUARD. Thank you very much, Mr. Volkmer.

I appreciate the testimony and the material that you gentlemen have prepared for us today.

I was reviewing the GAO report. I am sure that you are familiar with it. They say that FEMA really does not have its act together and it has not really played the strong Federal role that it should to prepare for emergency preparedness.

I think if I really try to make a composite of what you gentlemen have said here today, I would conclude that we do need a coordinating agency. There are so many causes of damage that we can't plan for all the possibilities because they are vast and would be hard to pinpoint. But certainly we do need a communications network and a backup program. Certainly this is vital to our national security, so we should assess our technologies to reduce our vulnerabilities.

Mr. Vaughan, I think that going back to Three Mile Island certainly indicates that the Federal Government has a very strong and a very grave responsibility as a lead agency—regardless of the fact that it is a private utility—in seeing that not only corrective actions are maintained, but certainly that the communications network is maintained in such emergencies. How are the States' efforts coordinated with the Federal Government? What would you do if we should have another one? Do you think we have learned in communication and preparedness? Who is going to take charge?

Mr. VAUGHAN. Madam Chairman, in the Three Mile Island incident, if we go back to what happened and not to what caused the problem, but once the problem occurred and thus emergency response measures were called for, I think the record indicates that Federal personnel were on the scene rather quickly, FEMA was the senior Federal Agency in charge, as the law and Executive order requires——

Mrs. BOUQUARD. Mr. Vaughan, we had 100 different voices trying to tell us what went on at Three Mile Island.

Mr. VAUGHAN. Certainly there was room for improvement about the communications with the public. But things like radioactive monitoring were on the scene very, very quickly, in a matter of a few hours. Those teams which work for me, not for FEMA, and for the Assistant Secretary of Energy for defense programs, were in fact dispatched and were on that scene very quickly, and they were there for a number of months. In fact, there is continuing monitoring of that situation from a public health, public exposure to radiation procedure. I think we have learned from the difficulties of State government and Governors wanting to be spokesmen as opposed to the FEMA coordinator, and so on.

As at any time with a major emergency, I think communications is always a problem. Certainly the Three Mile Island incident was not perfect in many respects. But basic public safety was protected, I think.

Mrs. BOUQUARD. I would like to bring up one more point. We had testimony in this subcommittee not too long ago that there was more news coverage over Three Mile Island than all of the space programs, all of their flights in the entire history of the space program. I think the reason for it is we did not have a principal spokesman. There was no lead person to inform the public or to make decisions as to what should be done at the proper time. I

cannot recall any reference to a FEMA representative being on site at TMI.

I certainly hope and pray that such a disturbance never occurs again. But I also remind you that I think that FEMA should certainly be prepared in these instances to give better guidance and coordination.

Mr. VAUGHAN. I can only respond to that, Madam Chairman, by saying that there has been a great deal of work done by FEMA and other Federal and State agencies to try to preclude that multiple-voicing in the future.

To be candid, however, a major incident of that nature, it seems to me, is very, very difficult to totally assure that there will only be one voice. As to how much press or how much devotion our press corps decides to devote to a particular incident, it seems to me almost impossible to predict in advance.

Mrs. BOUQUARD. With a space flight, we don't have five or six different agencies or groups reporting on a flight.

You say in your testimony that the responsibility lies with the managers and operators of the systems themselves. Do you feel that the Department of Energy is doing sufficient monitoring? Would you say that the utilities should clean up their act, or do they have things pretty well put together?

In other words, it may be the responsibility of TVA to make sure that they themselves are prepared and that they have the necessary plans and preparations for emergencies. But certainly, it is the Federal Government's responsibility to maintain oversight for reasons of national security to see that independent or the Federal power suppliers are prepared and assuming their proper role.

Mr. VAUGHAN. That is the very purpose of the work that we have going on at this very time, and that we have had going for the last year. It is to insure that the Federal needs are identified and properly prioritized within State, local, and regional systems. That is the very purpose of that work.

Mrs. BOUQUARD. Certainly lack of preparedness at the State level would be more critical than Federal action. But, at the same time, I think that proper monitoring and supervision is certainly imperative in this area.

Mr. VAUGHAN. I think there is—in fact, I know there is a fair amount of monitoring going on. We are dealing, as Mr. Gent has indicated, on a virtually continual basis with the utility industry's prime organization, the North American Electric Reliability Council. We deal with the utilities individually. We deal with the State energy offices and the public service of utility commissions that have some interest in this matter. And I believe it is fair to say that our States do have curtailment plans, if that is necessary, load shedding, and do have emergency response plans. In any system with 50 separate, sovereign entities, there is some variability. But I don't think it is fair to say that any State is unprepared. There is always room for improvement.

Mrs. BOUQUARD. Dr. Berger, in your written testimony, you mention that a superconducting fault current limiter might have prevented the blackout in 1977. What further R&D, if any, would be needed on this equipment to make it a reality, or what kind of re-

search would you see in the future that might be deemed necessary or practical?

Dr. BERGER. Madam Chairman, in collaboration with Westinghouse Corp., we have conducted what we term a paper study, a feasibility study, of this technology using the data we have obtained from the SMES program for the Bonneville Power Administration. The additional research that would be necessary would be to actually construct the hardware of at least one or more units, put it in place, and then apply a disruption to it to see if the hardware actually functions as envisioned. As I mentioned earlier, at least the paper study indicated that the concept is technically feasible, but, of course, it has not been checked out in the laboratory.

Mrs. BOUQUARD. Mr. Winn, is it time for you to catch your plane?

Mr. WINN. Yes, ma'am.

Mrs. BOUQUARD. I certainly appreciate your being with us.

At this time, I would like to, without objection, ask that each of you respond to questions from members of this committee that could not be with us today. There is a lot going on, as you well know, at this time. We do thank you for Mr. Winn being with us, and we excuse you now.

Mr. WINN. We would be delighted to do so.

Mrs. BOUQUARD. Thank you very much, Mr. Winn.

Mr. Gent, I think that the recent sabotage of a substation in Canada demonstrates that the Canadian power may not always be available. It seems to me that, certainly in the Northeast section of the country, that the power might be marginal because of the public sentiments against some of the construction by our utility companies.

Do you feel that the Northeast power demands can be solely met by generation in the United States without Canadian support?

Mr. GENT. The data and material that we have collected indicate a further reliance on energy from Canada over the coming years. It is quite possible, as we get into the 1990's, the answer will be no, that we must depend on Canada for our energy supplies. We have indications that we will have no more nuclear units built after the ones that are now under construction are completed, and we are encountering additional difficulties in building further coal-fired plants.

Mrs. BOUQUARD. For my information, is it a lack of communication or a lack of understanding of the consumers that they do not see the need to build additional capacity, or is it strictly a cost factor?

Mr. GENT. I think the latter, ma'am. Speaking for my wife, it doesn't matter whether it is Canadian or Mexican, just how much she pays.

Mrs. BOUQUARD. I mean a lack of understanding of the need to produce additional plants for security and for additional supply. That is my concern.

Mr. GENT. It is also ours. We have no answer as to why people cannot understand that.

Mrs. BOUQUARD. I would like your comments on the size of systems. Do you think there are advantages to restricting or limiting

the utility system sizes? Is there strength in larger systems, or do you think the smaller systems are more manageable?

Mr. GENT. As you know, we have systems that run from, say, 1 megawatt to control areas that operate at 35,000 megawatts. The size of a particular system is really not as important as the size of a particular control area. There may be as many as 15 systems in a single control area. The best example might be the Pennsylvania/New Jersey/Maryland interconnection which operates as a power pool. In fact, you are served now by that power pool.

Bob Iveson with EPRI—EPRI has done a number of theoretical studies to determine what the maximum size of the units and systems is. Bob, would you like to answer?

Mr. IVESON. I would say that we found no results yet that would indicate a maximum-size system. There is no doubt that you must provide the facilities and the monitoring devices so that, if a disturbance occurs, you can restrict or halt it. But in terms of an absolute maximum-size system, there hasn't been anything to demonstrate that it should be no larger than a certain size.

Again, the larger the system is, typically the larger the disturbance it can resist, as long as there are sufficient facilities available to enable the system to survive the disturbance. But those disturbances can be studied and you can identify where the natural locations are where the system might split.

Mrs. BOUQUARD. Do you feel that the Federal Government should become more knowledgeable of the regional concepts and needs and of the variations of supply?

Mr. IVESON. To some degree, I feel that they are already.

Maybe Mike would want to speak to that, but I believe that there are representatives that participate in that work.

Mr. GENT. Madam Chairman, you are probably referring to some of my written comments about regional regulation. NERC specifically is not supposed to deal in regulatory matters, but we find that when a utility is in two States, it is often influenced by the lesser and that, States being parochial institutions or governments, they are very often not concerned with activities of electric systems in other States, and electric utilities cannot observe State boundaries in these operations. So my written comments dealt with the fact that we need to have some mechanism where both Federal and State regulators can recognize the regionalness of electric utilities.

Mrs. BOUQUARD. Also in your written statement you mention increase in the cost of the electric power production in this area because of the delays in completing the Baltimore/Washington transmission loop. Is this a result of delays in construction? What caused this?

Mr. GENT. In one of those specific instances, there was a landowner exercising his rights, and he was backed by some rather well-financed, well-intentioned groups. The Baltimore/Washington 500 kV loop that I have cited in my testimony continues to be deferred over and over, and the customers are paying for that with higher cost electricity.

There are many instances like this. Our history is replete with situations where delays have increased our vulnerability and raised the cost to the ultimate consumer, generally over some issue that is

stuck in court, dealing either with environmental issues or health and safety issues or landowner issues, and things of those natures.

Mrs. BOUQUARD. Mr. Iveson, one area we haven't gotten into is what impact, if any, does the public utility commission have on the integrity of electric systems?

Mr. IVESON. Two that I would say. Coming from New York, the degree of reliability designed into the system is sometimes influenced by the regulatory action. In New York City, the level of events that are designed for are more stringent than they are in other areas in the United States, as advisably so with the large numbers of business, and so forth. That is what I would call a direct and specific impact.

I already mentioned funding.

Mrs. BOUQUARD. That is one area that I wanted you to expound on.

Mr. IVESON. To that degree, there simply is a relationship between funds available and what you do. In periods of low funding, you tend to curtail maintenance, for example. That will appear ultimately in the lower level of reliability that you should expect.

Mrs. BOUQUARD. Would you care to comment on the impact of the aging of powerplants and their effect on the national security.

Mr. IVESON. I believe there has been some work done which Mike might be aware of. The average age of a unit in the United States is now 20 years?

Mr. GENT. We house the data bank on our computer system for all electric generating units in the country. We have data on what causes the outage, how long it lasts, that sort of thing. From that, we try to draw some conclusions about aging.

We are tempted to say that, as a unit gets older, it is not as reliable. That seems to be a natural conclusion. However, we are going to investigate this in much more detail and in much more depth because there are all sorts of extenuating circumstances. Maybe you neglect that unit more as it gets older. So, we cannot come out and positively say that is true. There is some evidence that suggests that we should investigate this further, and we are going to do that.

Mrs. BOUQUARD. I would certainly like to have the results of your investigation. This is an area of major concern to me, that all our plants are aging and we are not producing any new ones. We are not turning out any nuclear plants this year. Pretty soon, this is going to catch up with us. If we aren't constructing more plants, we aren't going to have reliable facilities. It frightens me to a great degree.

Mr. GENT. We are very interested in this. We will keep you informed.

Mrs. BOUQUARD. We are talking about the differences in electric systems. Wouldn't this make a computer analysis rather difficult because of the differences in the powerplants and the source of the energy?

Mr. GENT. You put your finger on what the primary problem is. We have different types of equipment, they are in different localities with different types of cooling water, and they have different types of fans. But we do have all of that accounted for computer-

wise, and we are going to consider all of those various elements in our study.

Mrs. BOUQUARD. Do you think that maybe a need for new software may exist?

Mr. GENT. I don't think that we know what we want to study yet. If we were to be able to identify exactly what we wanted to do and how we were going to do it, then there might be an application for software.

Mrs. BOUQUARD. Mr. Iveson.

Mr. IVESON. If I may, I would support that there is a need. The analysis seems to become more complex as we go forward with it. In early analyses, maybe 10 years ago or 15 years ago, we looked at a disturbance for a few seconds. Today it is realized that, in many cases, you have to look at a disturbance for several minutes before you really understand whether the system is going to survive or not.

As you increase what we call the modeling time, the complexity of the equipment and how it works increases manyfold, so that we find ourselves going back, looking at models, and developing features in them that we didn't realize we would need, partly because the original requirements only said model for a certain time. So there is a learning experience that is now going on. As I say in my written material, I think minutes are now what we are trying to model well.

Mrs. BOUQUARD. Thank you.

One of you touched on stockpiling replacement equipment for emergencies. For anyone who wants to reply to this, what is the practicality of the Federal Government storing this equipment for use during emergencies? Is there a plan for who will pay the cost of delivering it? Has this been worked out, Mr. Vaughan?

Mr. VAUGHAN. There is no plan for the Federal Government to stockpile equipment for the electric power industry in general. That is a conscious decision thus far based on the studies that have been made. We may well conclude in these specific studies directed to specific Federal installations, primarily defense or prime defense contractors, that perhaps there should be some equipment—and I emphasize "perhaps"—stockpiled, or the utility urged to stockpile. Of course, the Government would pay for it.

But in general, I think we feel that there is so much diversity in the system—when you look at the country as a whole, there is no standardization—that what we might store at the Federal level would not have nearly the broad application that it might superficially appear.

As I think was indicated earlier in testimony of several of us in bits and pieces, there is a fair amount of stockage when you look across the country as a whole and it is down at the local level. Then the North American Electric Reliability Council, and we also have been interested, have attempted to set up communications—in fact, NERC has in fact set up communications—that will allow utilities to intercommunicate with each other to determine where equipment is if they need it, and they do, in fact, readily share it.

I believe we would find a Federal stockpiling of equipment to handle a national electric problem would be very, very expensive and of somewhat limited use.

Mrs. BOUQUARD. As you well know, this is a research and development subcommittee. I will throw this out for anyone who wants to comment: What further research and development would be feasible to increase the reliability of our transmission and distribution systems in case of an emergency?

Dr. BERGER. Madam Chairman, in my written testimony—and I touched on it briefly—I outlined some areas that are presently underway in the Office of Energy Systems Research and the Division of Electric Energy Systems where technology can play a role in improving reliability. Also, the Electric Power Research Institute does fund studies in different areas. There is a vast array of technologies presently being looked at throughout industry and, as I mentioned, the universities and the national labs. They are looking at new technologies that can improve reliability. I refer to those areas outlined in my testimony as possible areas.

Mrs. BOUQUARD. Thank you very much.

Mr. Iveson.

Mr. IVESON. As I indicated, EPRI at this point is directing the majority of its resources toward near-term results. That is primarily as a result of the State regulatory bodies who have to justify to the consumer how those funds are being used.

To that degree, areas of high risk are generally not being covered at EPRI. High risk is very difficult to ascertain whether there is going to be a good result. But I would say that within the scope of the work we have ongoing at EPRI, we have a reasonably good proportion of our funds in the reliability area. If there were questions raised in high-risk areas, then I don't believe we have funding in those areas now.

Mrs. BOUQUARD. Thank you very much.

Are there further questions?

Mr. VOLKMER. Yes, I have a question that anyone could ask about. I was just reading an article from the December 5 Washington Post on the dangers of electromagnetic pulse conditions occurring as a result of a nuclear warhead explosion 50 to 75 miles up.

Does anybody know if there has been any research on the effects on the transmission of electricity? That article said it would trip the circuit breakers throughout our power grid. Has there been any research on this?

Mr. GENT. This is like jumping into the frying pan.

We have conducted research on this subject for years. We basically concluded it was not a problem. There were some isolated——

Mr. VOLKMER. How do we explain what happened in the atomic blast off of Hawaii back in 1962?

Mr. GENT. I am not familiar with that.

Mr. VOLKMER. What happened in Hawaii was you had failure with lights, fuses blown and everything else How do we explain that then?

Mr. GENT. It is because of occurrences like that and articles like that the question is being reexamined now. There were some studies at EPRI—I don't want to speak for them—but I understand that there are going to be some more in this area.

In short, we don't have a good answer for you.

Mr. VOLKMER. As I understand it, out in Los Alamos—someplace—we have a simulator that can produce electromagnetic pulse that can be used with experiments right now.

Dr. BERGER. Yes, Congressman Volkmer. That simulator is at Kirkland Air Force Base in Albuquerque. It is primarily used for the test of aircraft.

Mr. VOLKMER. Yes.

Dr. BERGER. Simulators exist for testing electronics at other laboratories throughout the country.

As far as research goes in that particular area, if I could introduce Mr. Ray Dunlop of the DOE's Division of Electric Energy Systems, who is in the audience, I believe they are planning to do some research and studies in that particular area in the forthcoming years. I do also know that the Defense Nuclear Agency is presently planning on funding a modeling effort that would have the multiple sources necessary to try to evaluate if such drastic outages as predicted would really occur.

One area I might mention is that, under DOD sponsorship and internal laboratory funding, we have also looked at new electronics. If you recall, the article you are referring to mentions the fact that vacuum tubes are basically radiation hard and solid-state electronics have a problem due to the small distances. We are very currently investigating thin-film vacuum tube technology which is—if I can paraphrase and perhaps oversimplify—basically vacuum tube technology in 1970 solid-state size. One cannot completely replace solid-state electronics with these types of systems, but it is possible that, with considerable research and development, they could be utilized to replace key components.

Mr. VAUGHAN. Congressman, I would like to make two points on your question. One, I am familiar with the article you reference. Some of the theories espoused in that article, I think it is fair to say, are controversial as to whether in fact they do constitute a danger. It is also true that my office just let a contract with the Oak Ridge National Laboratories specifically directed at this very subject and its impact upon electric power systems.

So I think the answer to your question basically is that there is work going on.

Mr. VOLKMER. Thank you very much.

Thank you, Madam Chairman.

Mrs. BOUQUARD. Mr. Vaughan, the surge protection systems, would they protect our systems against EMP?

Mr. VAUGHAN. Would you please restate your question? I am sorry, I didn't get your question.

Mrs. BOUQUARD. The surge protection systems, wouldn't they basically protect against EMP?

Mr. GENT. I think your concern is that if we have this EMP phenomena, if it did affect our solid-state devices, they would all trip. This wouldn't be any disaster, except we would have to start from black again—meaning that area would be blacked out—and we would have to bring the system back up after the trip. Yes, that is the theory, that electromagnetic pulse would cause our solid-state devices that we have in the relays that protect large equipment to just trip and everything would be open, our plants would go down,

the lights would go out, and we would have to build the system back again. The equipment would not be destroyed.

Mrs. BOUQUARD. I understood that the magnetic fusion program had developed surge protection devices. Could these be used?

Mr. GENT. I don't know.

Mr. VAUGHAN. Madam Chairman, there is a fair amount of work going on in that broad area, a large part of which, I believe, is classified because it affects the nuclear weapons program. I think, if we want to go further down that path, we ought to look at where the security stops and starts, quite frankly.

Mrs. BOUQUARD. Thank you very much.

Thank you, gentlemen. It certainly was excellent testimony. I certainly appreciate your participation.

Thank you very much.

If there are no further comments, the subcommittee is adjourned.

[Whereupon, at 4:02 p.m., the subcommittees were adjourned.]

APPENDIX

QUESTIONS AND ANSWERS SUBMITTED FOR THE RECORD

Department of Energy
Washington, D.C. 20585

January 31, 1983

Honorable Marilyn Lloyd Bouquard
Chairman, Subcommittee on Energy
Research and Production
House of Representatives
Washington, D.C. 20515

Dear Ms. Bouquard:

On December 9, 1982, Assistant Secretary William A. Vaughan testifed before the House Science and Technology Subcommittees on Energy Development and Applications and Energy Research and Production regarding the Integrity of Electric Energy Systems. Following the hearing you requested responses to questions submitted by Members of the Subcommittees. Enclosed are the responses to those questions.

If you have any questions, please call Diana Diamond or Tom Pretorius of my staff on 252-4277. They will be happy to assist you.

Sincerely,

Thomas H. Pretorius

for Robert G. Rabben
Assistant General Counsel
for Legislation

Enclosures

cc: Ms. Mary Bly
Committee on Science
and Technology

18-363 O—83——7

Question: In the Fall of 1980, various groups and individuals opposed the construction of a 400 kilovolt transmission line built by the United Power Association of Elk River in Minnesota. Specifically, an organization called the "General Assembly to Stop the Power Line" is known to have participated in efforts to halt the construction. Substantial damage was done including the complete destruction of 14 transmission line towers. Has the vandalism stopped? Was anyone apprehended in connection with the reported $7 million damage? Did the FBI actively participate in controlling the situation?

Answer: Vandalism has stopped on the United Power Association DC transmission line. There were arrests in the early stages of the vandalism activity, but the cases were dismissed from the local courts.

FBI involvement was a major issue, allegedly because local authorities were sympathetic with the farmers. The FBI did become actively involved after ownership of part of the line was transferred to the Rural Electric Administration. The vandalism ceased shortly after the FBI became involved.

These acts of vandalism (which occurred many times from 1977 through 1980 against this line) did not cause any sort of "crisis". The main effect was to increase the utility bills by restricting "economy interchanges" between the electric systems on either side of the subject transmission line.

As indicated in the testimony, this type of incident does not require increased DOE involvement.

Question: The GAO report of September 13, 1982 claims, "The federal government is still not adequately prepared to respond to major electrical emergencies." Please forward any additional comments you would care to make in response to that report and if appropriate, identify any support your organization might need to strengthen federal participation in this area to the extent such participation is needed.

Answer: While we agree that the subject addressed in the GAO report requires serious attention, we do not agree with all of the conclusions and recommended approaches contained in that report.

- The nature of the problem, as well as the existing capability of the industry to deal with the problem, are not sufficiently well understood. We believe it is first essential to carry out technical analysis at a considerably greater level of detail than has been done in the past by GAO and others.

- We are currently reviewing what actions DOE should be prepared to take. For example, we have asked NERC to comment on the current types of DOE assistance that are available in emergencies resulting from acts of nature, and to suggest other areas where DOE could provide help. We will later solicit suggestions regarding DOE response to hostile incidents.

- DOE is also analyzing the need for legislative initiatives to enhance utilization of the Electric National Defense Executive Reserve in planning for and responding to severe national electrical emergencies by minimizing antitrust, conflict of interest, and other obstacles.

- The GAO report either ignores or incorrectly characterizes several important developments, such as:

  -- DOE's program plans, organization plans,and training manuals for all three executive reserve units for which DOE has responsibility: the Emergency Electric Power Executive Reserve (EEPER), the Emergency Solid Fuels Executive Reserve (ESFER), and the Emergency Petroleum and Gas Executive Reserve (EPGER).

  -- The vulnerability assessment activities discussed in the December 9 testimony.

More fundamentally, we believe that the primary capability and responsibility for dealing with major electrical emergencies, no matter how severe, lies with the utilities. For example, the recent situation in California involved the loss of seven transmission lines and substantial load shedding. DOE was prepared to provide assistance, but none was required. In Hawaii, the power system was severely damaged, yet most service was restored in a week. It is hard to imagine a situation where it would be useful for DOE, or any other Federal agency, to have a dominant role in managing an electric power contingency or the subsequent recovery period.

Question: What is your organization doing to prepare for electric power disruption in an event involving electro-magnetic pulse effects?

Answer: Since EMP effects may occur in conjunction with a high-altitude nuclear detonation, any preparation must be part of overall preparation for nuclear attack. Although there is widespread concern among defense planners about the possible effects of EMP on the control systems of modern electric power networks (as well as on communications systems), there is a deficiency of engineering data.

The DOE Electric Energy Systems Division (EES) is initiating through Oak Ridge National Laboratory a research program to improve the level of scientific and engineering knowledge of EMP effects on electric power systems. These efforts are being coordinated with appropriate DOE and DoD offices so as to minimize duplication of research. The initial phase of the EES research and development program involves the development of models and simulation methods necessary to determine how EMP transient surges are coupled into electric power networks, and to assess their propagation through the transmission and distribution networks to electrical apparatus. Once theoretical models and transient propagation methods are verified, a preliminary assessment will be made to determine how power system insulation, equipment, and surge protection apparatus may be impacted by EMP events. If significant disruption and/or equipment damage are possible, investigations will be conducted to assess various operating and control strategies and protective hardware alternatives which can mitigate or minimize vulnerability of power systems to EMP effects.

Our Emergency Electric Power Executive Reserve (EEPER) unit is also reviewing measures that utility systems can take to reduce their vulnerability to EMP and is coordinating with the EES effort. We are also coordinating with the National Communications System on this issue.

However, the Nation's "preparation" for EMP events is likely to remain incomplete until a great deal more engineering knowledge is developed. Current Defense Department activity to harden communications systems to protect them against EMP has been very expensive. Any significant improvement of the protection of electric utility systems against EMP effects would require substantial funds, which the utilities are unlikely to expend until the risk is better quantified.

Question: In what way is the Federal government either prepared or not prepared to act in major electrical emergencies?

Question: What specific plans has DOE prepared to respond to acts of vandalism, violence, or sabotage caused by organized belligerents?

Answer: DOE is prepared to provide various types of assistance, such as:

- Appropriate utilization of the Emergency Electric Power Executive Reserve;

- Coordinating with FEMA and assisting a utility in obtaining portable equipment available through the military services or other government sources;

- Coordinating with FEMA and obtaining assistance from the military services or other government sources in transporting equipment or work crews;

- Helping to locate privately available equipment;

- Assisting, when requested by the affected utility and/or state or local officials, in obtaining temporary waivers of government restrictions (for example, the clean air and water requirements of the EPA) to allow full use of operable resources while remaining resources are undergoing repair; and

- Exercising DOE's authority to provide assistance in obtaining emergency interconnection and transmission service under Section 202(c) of the Federal Power Act, where such assistance would help alleviate the situation.

It is not DOE's policy "...to respond to acts of vandalism, violence, or sabotage caused by organized belligerents" unless it is either necessary under statutory authority or judged necessary if a request is made by industry or local government. It is, however, DOE's role to assess the capability of the energy industry to respond to or mitigate acts that have been ascertained to be likely to occur and to have significant impacts.

Question: Have you or any member of your organization coordinated activities with the FBI or cooperated with the FBI in matters involving vandalism or disruption to electric power facilities?

Answer: With regard to specific criminal acts (except those involving DOE facilities), the electric power industry works directly with the FBI and other law enforcement authorities, without DOE's involvement.

The DOE Office of Safeguards and Security, under the Assistant Secretary for Defense Programs, is in frequent contact with the FBI and coordinates closely in incidents involving DOE facilities. The Nuclear Emergency Search Team also coordinates with the FBI in incidents or threats involving nuclear materials, whether or not in DOE's custody.

Security and other personnel at DOE's field facilities and power marketing administrations have contacts with the local FBI offices as well as with state and local law enforcement agencies when required.

The electric power vulnerability study project discussed in the December 9 testimony has also been coordinated with the FBI -- particularly the task on threat assessment.

Question: Has DOE given DoD any support for energy emergency planning?

Answer: Through the President's Emergency Mobilization Preparedness Board (EMPB) activities, DOE is coordinating with DoD on a number of emergency planning issues.

DOE also works directly with various DoD offices on matters such as Defense Production Act planning, the winter operations plan for liquid fuel procurements, and assuring fuel supplies for civilian federal agencies through the Defense Fuel Supply Center (DFSC).

As explained in the testimony,the energy supply vulnerability studies are also being coordinated with DoD, as are certain aspects of the National Defense Executive Reserve activity.

Question: What near real-time crisis management systems has DOE developed for energy emergencies?

Answer: DOE has recently forwarded a report to Congress providing summary descriptions of all such systems and procedures ("A Report to Congress: Comprehensive Energy Emergency Response Procedures," DOE/EP-0081, December 31, 982). A copy of this report is enclosed.

[The report mentioned above is available from subcommitee files.]

Question: Since DOE and FEMA have no authority over utilities in case of emergencies, such as a major loss of generating capacity or transmission lines, how effective could DOE or FEMA be in actual crisis management?

Answer: DOE does have some authorities that can be used in applicable circumstances, such as the Federal Power Act (Sec. 202(c)) and the Defense Production Act. However, DOE cannot, and will not, assume responsibilities of the utility industry. A major loss of generating capacity or transmission lines is not an uncommon occurrence, and the industry has continued to demonstrate the ability to utilize the resilience of its systems to manage such "crises".

Since DOE's role in "crisis management" is primarily to provide assistance, coordination, and monitoring, the current authorities are adequate. Broad DOE "authority over utilities" would not be appropriate or useful.

Question: What is your analysis of the contingency plan developed by the National Petroleum Council on how to handle various levels of potential oil impact curtailment?

Answer: This report, done at DOE's request, contains useful industry analyses and opinions on several aspects of contingency planning covering all forms of energy. Parts of it are used for planning purposes but it does not represent a DOE policy.

In particular, we strongly disagree with that report's contention that standby price control and allocation authority is desirable to have in the event of a major supply disruption. Experience clearly indicates that such controls only make matters worse, and the mere existence of such standby authorities discourages self-insurance efforts on the part of private businesses and individuals.

The report did not consider problems arising from physical damage to domestic energy distribution systems.

Question: What data bases do you have for crisis management?

Answer: DOE has access to a variety of data bases, some of which serve as sources for the Energy Situation Reporting System (ESRS), a DOE emergency preparedness real-time data system. For electric system information, these include:

- Daily operating status reports on nuclear powerplants, from the Nuclear Regulatory Commission (NRC), as well as lists of projected nuclear units with scheduled completion dates.

- Reports on all major electric power supply disruptions.

- Information from the NRC on average availability, forced outage rates, maximum and minimum available capacity, and other derived data concenring nuclear units.

- Edison Electric Institute (EEI) weekly and monthly generation reports.

- Energy Information Administration (EIA) reports on monthly generation by fuel type, and monthly utility fuel stocks and consumption.

- Reports from the individual Reliability Councils and regions on projected capability and new units scheduled, as well as EP-411 reports from the councils on existing and projected generating units, loads, and reserves.

- Data from the Canadian National Energy Board and the Canadian embassy on imports of electricity from Canada.

- Data from EEI on circuit miles of transmission by voltage class, and derived information on average energy carried by transmission network, transmission system losses, etc.

- The EIA Generating Unit Reference File (GURF), a comprehensive listing of installed generating units with fuel type, capacity, location, and owner.

The ESRS also contains many supply and demand data sets relating to other energy sources, as well as key news and weather information that impacts energy supplies.

Question: What systems do you need for real-time crisis management?

Answer: DOE needs proper points of contact with energy supply operations centers, as well as dedicated communications systems. Over the past year, the systems and data bases available for crisis management have improved to the point where they already provide a considerable amount of capability.

DOE is continually evaluating available government and private sector systems and data bases to ascertain their usefulness to the Office of Energy Emergencies.

A variety of minicomputers and displaywriters have improved DOE's ability to quickly access, organize, and display data in support of emergency coordination and assistance operations.

DOE realizes that experienced personnel will be more important than systems and equipment in "real-time crisis management". Therefore DOE will continue maintaining a viable Energy Executive Reserve and will seek consultation and coordination with the knowledgeable industry representatives.

Question: As you know, there are new available, very sophisticated computerized systems that can access data bases and provide interactive graphics. Could such systems be used not only for crisis planning like war-gaming, but also for crisis management during extended power interruption? Does DOE or FEMA have this computer graphics capability? If not, what steps are being taken to develop it?

Answer: DOE has sufficient computer capability, including graphics, relative to the role DOE would have during crisis situations. As stated in the December 9 testimony, DOE is not the principal actor in such situations. DOE provides assistance when appropriate to utilities and to state or local governments, and supports FEMA, which is the lead Federal agency in crisis situations.

We do not see the need to develop a massive capability to acquire and display detailed real-time utility system operation information, such as would be available at a regional utility control center. Such a capability would be enormously expensive and would, we believe, serve no useful purpose, since detailed operational decisions could under no circumstances be made at the Federal level.

Question: According to the GAO, FEMA is charged with setting policy and coordinating the "National Defense Executive Reserve" Program (NDER) under Executive Order 11179. What policy guidance have they provided to DOE which will enable you to better manage your program?

Answer: DOE's executive reserve program has been coordinated with FEMA to assure consistency with overall policy regarding all executive reserve units. However, the development of the overall management approach has largely been DOE's responsibility. DOE will be actively participating in the FEMA national meeting of Executive Reservists to be held in early March.

Question: What is the role of FEMA in emergency electrical outage situations?

Answer: FEMA would be unlikely to be directly involved in the problems of restoring the power system. This would be the responsibility of the utility or utilities involved, plus state and local authorities. However, FEMA might provide assistance in coordination, communications, or facilitating certain operations, such as arranging for military air transport of critical replacement items. During prolonged outages, FEMA might also provide various kinds of relief or assistance to the population affected by the outage. FEMA is, of course, best qualified to answer questions concerning its responsibilities during such emergency situations.

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Question: Are the number of incidences over the past 10 years involving vandalism, sabotage, or other acts of violence against electric power production, transmission and distribution systems increasing, decreasing or remaining constant? Please provide statistics if they are available.

Answer: There are no definitive statistics on such acts, because a large fraction are not reported at all, or are reported only to local authorities.

However, a number of reports have provided lists of various types of hostile events that have involved energy systems in recent years. Examples are:

- "Potential Saboteurs to DOE Programs: Attributes and Inferences," ATAR 1014.80, Advanced Technology Associates, Inc., September, 1980

- "Chronology of Actions Against Non-nuclear Energy Programs in the United States and Abroad," WD-1264-SL, Rand Corporation, October 1981

- "Quarterly Risk Assessment," prepared quarterly by Risks International, Inc., Alexandria, Virginia.

It is difficult to compare different estimates due to differences in the sources of data and in the definition of a "threshold event". However, the overall incidence appears to

have neither increased nor decreased dramatically over the past few years. Some reports have indicated an increase in "petty" acts, such as vandalism or theft, while others have indicated a moderate decrease in major hostile acts, such as the terrorist attacks in the early 1970's.

The primary concern of DOE's vulnerability assessment program is that, during some future period of international hostility or domestic unrest, concerted attacks against power systems might offer a low-cost, high-leverage option to an adversary. Such attacks have fortunately never occurred in the United States; therefore, the statistical trends concerning the incidence of lower-level events may have somewhat limited relevance to our work. As indicated in the December 9 testimony, we feel that the industry has an excellent track record in dealing with such events and does not require an increased level of DOE involvement.

Question: In reviewing the 1977 New York blackout, the Committee noted what may be an unusual number of equipment malfunctions which aggravated the situation and intensified the problem.

Specifically:

1. An inadequately grounded transmission line tower in Weschester County;

2. Circuit breakers that failed to reclose after line fault (a loose locking nut resulted in a pressure drop in one circuit breaker and a disconnected closing circuit in another caused the malfunction);

3. An improperly designed circuit breaker opened at Indian Point 3 which disconnected the reactor from its load;

4. An improperly designed timer on the Hudson tie line caused a premature trip;

5. A bent relay contact on a 345 kv line caused the line to trip out on a temporary voltage surge;

6. An antiquated control room design in which confusion resulted in improper operation; and

7. Equipment undergoing maintenance that was <u>not</u> removed from the "ready list."

Are examples 1 through 7 accurate? Did the September 26, 1977 storm also disclose faulty equipment in the Consolidated Edison system? Is this condition typical; that is, does this level of required corrective actions exist in other utilities? Would it be fair to say these standards of design, workmanship, operation and maintenance are the result of a generally poor job attitude on the part of working crews? Is it poor supervision? Finally, how does this quality assurance problem impact electric systems vulnerabilility?

Answer: The events associated with the 1977 New York blackout were documented in detail in the final staff report of the Federal Energy Regulatory Commission (FERC), DOE/FERC-0012, published in June 1980. Many other reports by the FERC staff, the utility, and others have dealt with the various technical problems and the implementation of recommended mitigation measures.

The occurrence of various isolated malfunctions, such as those cited in this question, is not abnormal in a large utility system, nor is it necessarily evidence of poor quality assurance, job attitude, or supervision. Large power systems consist of many thousands of components. Despite testing and other quality assurance efforts, there can be no assurance that all components will work properly at all times. Therefore, the systems are designed with enough redundancy and resilience to assure a high probability (though never an absolute certainty) of successful overall operation despite individual component failures.

Quality assurance for system components is of course important, but even if all components were in perfect operating condition, they would not be indestructible. Therefore, a power system would still be vulnerable to external events such as natural disasters or hostile acts. The resiliency of the system in responding to such adverse events is more likely to be enhanced by increased redundancy, improved repair capability, and changes to operating procedures, than by improved quality assurance.

Los Alamos
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

DATE February 23, 1983
IN REPLY REFER TO CEL/AES/83-172
MAIL STOP F682
TELEPHONE (505)667-3973
FTS 843-3973

Mr. Ron Williams
Subcommittee on Energy Research and Production
House Science and Technology Committee
Rayburn Building
Washington, DC

Dear Ron:

Thank you for the opportunity to appear before the two Subcommittees and to respond to the Members' questions. My responses are attached, as are my corrections to the recorded testimony.

If my responses to the questions need any additional clarification, or if I may be of further assistance, please do not hesitate to ask.

Sincerely,

L. R. Skaggs Jr.

[redacted]
Deputy Associate Director for
Alternative Energy Sources

MEB:srw

Attach.: 1) Responses to Questions
2) Recorded Testimony Corrections

cc: CRMO, (2) MS A150, w/1 of Attach.
J. M. Liersch, ADIR, MS A168
J. H. Birely, ADCEL, MS A102
CEL/AES file

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CEL/AES/83-173
February 23, 1983

RESPONSES TO QUESTIONS FROM THE HOUSE SCIENCE & TECHNOLOGY COMMITTEE

FOLLOWING TESTIMONY OF MICHAEL E. BERGER

BEFORE

SUBCOMMITTEE ON ENERGY DEVELOPMENT AND APPLICATIONS

AND

SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION

US HOUSE OF REPRESENTATIVES

DECEMBER 9, 1982

On January 6, 1983, the Chairman of the two subcommittees forwarded twelve questions to Dr. Berger. The attached answers are in the same order as the questions.

Attachment 1 to
CEL/AES/83-172

Q. Is it possible that stability evaluations are expensive because they are attempted on large general purpose or technical computers rather than on specific hardwire processors? Are they mathematically reliable? Please comment.

A. Because of the complexity of the problems, it would be virtually impossible to do detailed calculations on hardwired or analog computers. Therefore, it is necessary to perform these calculations on general purpose digital computers. The stability evaluations are expensive because of the complexity of the problem. For example, it was pointed out in testimony before the two subcommittees that there are more thar 11,000 generating plants. In addition, there are hundreds of thousands of interconnections of the electrical network. A precise mathematical model of a system this complex can only be performed with certain assumptions and then only on large digital computers. These mathematical models use finite difference techniques that are common to engineering and scientific practice. However, by virtue of being mathematical approximations a small error is inherent to these calculations. By utilizing new and advanced solution techniques and by validating the computer codes against experimental data, these calculations can be shown to be extremely reliable. In a sense, it is the goal of reliability that makes these stability evaluations expensive because in order to achieve more reliable calculations, longer running times and more precise representations of the network are required.

Q. You state that a shift to dispersed alternative technologies might not provide for more stable electric power systems. To the untrained eye it would appear otherwise; would you please explain or elaborate on this?

A. As noted in my testimony, I agreed that, a priori, a shift to dispersed alternative technologies might seem to provide for more stable electric power systems. However, after 20 years of mathematical modeling of similar systems on computers, I have learned that one should never prejudge the stability of a given system. Under the Public Utilities Regulatory Power Act, utilities are required to accept and purchase excess power from dispersed alternative technologies. My concern is that under a combination of unusual weather conditions and an unexpected set of disruptions to the system, a utility could find itself in an unstable situation unless it were able to shed the incoming power from these dispersed technologies. I do not expect this to happen; however, it is a situation that should be evaluated analytically before definitive statements are made about dispersed technologies.

Q. You mentioned numerous R&D needs. What past research has Los Alamos performed, and under whose sponsorship, which has resulted in technology to reduce energy vulnerability?

A. In a broad sense, almost all energy R&D performed at Los Alamos may be thought as technology development to reduce energy vulnerabilities. Let me use passive solar as an example. Our work in passive solar, funded by the Department of Energy, has shown that a good passive solar house will not freeze anywhere in the United States. As a matter of fact, in most instances, the temperature of a good passive solar house will not drop below 50°F even without auxiliary heating. Therefore, if we had wide-spread use of good passive solar technology, in times of an energy crisis, we would not have to close schools and factories and then send people home to burn precious fossil fuels in inefficient buildings as has happened in 1974. Other areas of research that pertain to this question are our nuclear energy research, the Hot Dry Rock Program, fossil energy, and the conservation programs, all funded by the Department of Energy. Some specific examples are as follows:

- Superconducting Magnetic Energy Storage (SMES)

Although the SMES technology was originally conceived as a load management technique for utilities, which in its own way is a means of reducing energy vulnerability, the current program is focused on providing stable power for the Bonneville Power Administration. This is an excellent example of technology that can reduce energy vulnerabilities. In addition, small SMES units could be conceived to provide back-up power for moderate periods of time to key installations if their power were disrupted.

- Superconducting Transmission Line (SPTL)

Los Alamos has played a role in developing materials technology for the SPTL. Since the SPTL is an efficient means of power transmission, and they are buried, this is another way of technology can be utilized to reduce energy vulnerability.

- Superconducting Fault Current Limitor (SFCL)

I referred to the Supperconducting Fault Current Limitor in my testimony. This technology, developed on internal funds, could protect against surges as that that occurred in the 1977 New York Blackout.

° Photoconducting Electronics (PCE's)

The PCE technology, developed on internal funds, could provide sensing and switching capability on a picosecond time frame. This technology could be utilized in many ways to reduce electrical energy vulnerability. In addition, power supplies utilizing this technology could be smaller, more reliable, and much more efficient. This technology is still in the research phase but shows great promise.

° Integrated Thermionic Circuits (ITC's)

This is another technology, developed on internal funds and now supplemented with DoD funding, that can provide radiation-hardened electrical systems. I mentioned it in my testimony. Although, it is not envisioned that complete electrical systems could be replaced with this technology, key components and circuits could be, therefore making them more reliable in high-radiation and EMP environments.

° Systems Analysis

Although not considered technology itself, Los Alamos has performed many system studies in the area of electrical energy distribution systems, evaluating trade-offs between large versus small power plants. These studies were performed under DOE sponsorship.

Q. You mentioned the need for improved materials for surge protection devices. Please define the specific projects and research areas which you consider essential.

A. Amorphous metal oxide semiconductor materials are now being used in surge arresters to provide enhanced protection of power system equipment from transient overvoltages caused by switching surges and lightning strokes on transmission and distribution lines. In the future, these same generic materials may provide a means to suppress electromagnetic pulses (EMP) from high altitude nuclear explosions that couple to the electric network. Research is needed on the physics of these semiconductor materials to reduce losses and the resultant thermal transient when conducting high surge currents and to enhance their transient response characteristics.

By reducing losses, the size and cost of arresters for a given level of surge protection duty can be significantly reduced. Improved transient response characteristics can lead to reduced insulation requirements on transmission lines, transformers and substation equipment, which has a very high benefit to cost ratio. Enhanced thermal and transient properties may also lead to surge arresters capable of handling the extreme duty requirements of occasional very high intensity lightning surges or the very high rate of rise in transient overvoltage that may be associated with EMP effects on transmission and distribution facilities.

Q. Does Los Alamos National Laboratory plan to continue studies of military energy security? If so, how will these studies be funded?

A. Los Alamos does plan to continue our studies of military energy security. Present funding for these studies comes from internal funding and from funding by the Air Force.

Q. Does the fact that electric power systems are under civilian control jeopardize defense preparedness and if it does, how might this committee alleviate the problem?

A. It would be unrealistic to consider electric power systems that were not under civilian control. The military does not want to be in the business of buying, operating, and maintaining power plants. An alternative would be to utilize recent legislation that provides for third-party ownership of power plants on military bases. One problem with this legislation is that it excluded nuclear power plants from being incorporated in this concept. Under third-party ownership, the military could sign a long-term lease with a utility for secure electric power. The military would provide the land and security facilities, and the utility would then construct, operate, and maintain the power plant. Any excess power from the plant could be input to the utilities network. The committee could help in this area by addressing the issue of allowing all sources of power production, including nuclear, to be allowed under the third-party ownership concept for military bases.

Q. How is research and development of technologies, which could reduce vulnerabilities, shared or at least coordinated between DoD and DOE? What action should this committee take if such R&D is not coordinated?

A. The current means of technology transfer between the DoD and DOE is through the Inter-Agency Power Group (IAPG). Although not specifically targeted at technologies which could reduce energy vulnerability, this agency is made up of several subgroups which do share technology.

In addition to the two above mentioned groups, research and development is being carried out by the Electric Energy Systems Division of DOE to reduce the vulnerability of power systems to severe disturbances caused by natural disasters or by civil or military actions. This research is aimed at providing sophisticated tools and equipment concepts enhancing emergency detection, control, operation, and system restoration and minimize damage to electrical equipment and systems. As these high technology enhancements are transferred to the electric utility industry, the resultant improvements in system security will also reduce the vulnerability of energy supply to the nation's defense installations and critical defense supply industries.

Adequate arrangements are not yet in place between DOD and DOE to insure that research efforts are coordinated and the results are shared. However, attempts to better coordinate these efforts are being pursued by Los Alamos. For example, the DOD has carried out extensive research on the nature of electromagnetic pulses (EMP) caused by high altitude nuclear blasts and their impact on defense facilities such as aircraft, ships, missiles and critical command, communication and control facilities. The results of DOE research on EMP characteristics will be fully utilized in the DOE program, sponsored by the Electric Energy Systems Division, to investigate the impacts of EMP on electric power systems; and the results will be utilized by DOD to evaluate vulnerability of electric energy supply at defense installations caused by EMP events. This DOE Electric Energy Systems project is being directly coordinated with representatives of DOE's Office of Emergency Preparedness, the Defense Nuclear Agency, the Federal Emergency Management Agency, the Air Force Weapons Lab, the Nuclear Regulatory Commission, and the Electric Power Research Institute.

Q. What R&D should the federal government continue with or initiate to lessen the vulnerability of electric power systems?

A. Several areas have been mentioned in my prepared testimony. With regard to the list of longer term, basic research areas mentioned in the last page of my testimony, all those areas are being considered for implementation in the Electric Energy Systems program in the DOE Office of Energy Systems Research. DOE research at Los Alamos on hardening of electronic systems to high radiation levels may be particularly useful, if warranted, for hardening power systems detection, communication and protective relay functions against EMP effects. Although the Electric Energy Systems program is motivated primarily by the need to enhance security of electric power systems and reduce public impacts of major disruptions caused by natural disasters, there is no question that success in such long term research will also help to reduce vulnerability of power systems to sabotage, terrorism and large scale military actions.

Q. In your written testimony, you referred to an increase in major power outages from 23 in 1979 to 45 in 1980. If you feel this is a trend, what other information do you have to support it?

A. I do believe this is a trend because power systems are becoming more complicated with many more interties. Reports of vandalism against electrical power systems seem to show an increase. In addition to the EPRI data presented in my testimony, Figure 1 of my prepared testimony shows that the interruptions over 100 megawatts power increased from approximately 42 in 1971 to over 100 in 1980. Further data to support this belief is presented in DOE Report HCP/T5103-01, "Impact Assessments of the 1977 New York Blackout," 1978. This report shows that electric power disturbances over 50 megawatts increased from 18 in 1971 to more than 48 in 1977.

Q. In your written testimony you mentioned that "Power generating stations are more secure." Some people suspect nuclear plants are, but what is your impression of the security provisions of fossil and hydroelectric plants?

A. Los Alamos investigated the security of power plants several years ago and recently during our energy vulnerability studies. In general fossil and hydroelectric plants have physical security in terms of fences, locks, and perhaps some security personnel. Much of our information concerning security provisions at fossil and hydroelectric power plants is classified. I am somewhat reluctant to go into specific detail for fear of leaving a blueprint for a potential adversary. In general, it is a true statement that security provisions at fossil and hydroelectric plants are not as adequate as those for nuclear plants.

Q. Our committee has supported R&D at the Barnwell Nuclear Fuel Plant in South Carolina. Some of the detection, recognition, and monitoring systems that came out of that effort appear quite permittable: voice recognition, for example! What efforts would you recommend in this area for substations and transmission lines?

A. By their very nature, it is virtually impossible to provide security provisions for transmission lines. Burial of transmission lines appears to be the only means for providing enhanced security. Substations can utilize technology to be made more secure, however again, it would be virtually impossible to provide security for the multitude of substations that exist against an adversary with a high-powered rifle or military weaponry. The technology referenced in the question could be utilized in enhancing security of power generating stations.

Q. In reviewing the 1977 New York Blackout, the Committee noted what may be an unusual number of equipment malfunctions which aggravated the situation and intensified the problem. Specifically:

1. An inadequately grounded transmission line tower in Westchester County;

2. Circuit breakers that failed to reclose after line fault (a loose locking nut resulted in a pressure drop in one circuit breaker and a disconnected closing circuit in another caused the malfunction);

3. An improperly designed circuit breaker opened at Indian Point 3 which disconnected the reactor from its load;

4. An improperly designed timer on the Hudson tie line caused a premature trip;

5. A bent relay contact on a 345 kv line caused the line to trip out on a temporary voltage surge

6. An antiquated control room design in which confusion resulted in improper operation; and

7. Equipment undergoing maintenance that was not removed from the "ready list."

Are examples 1 through 7 accurate? Did the September 26, 1977, storm also disclose faulty equipment in the Consolidated Edison system? Is this condition typical; that is, does this level of required corrective actions exist in other utilities? Would it be fair to say these standards of design, workmanship, operation and maintenance are the result of a generally poor job attitude on the part of working crews? Is it poor supervision? Finally, how does this quality assurance problem impact electric systems vulnerability?

A. The example 1 through 7 are esentially accurate as they were documented in the final report of the Federal Energy Regulatory Commission (FERC), DOE/FERC-0012, June 1980. There was faulty equipment in the Consolidated Edison system. As noted in my testimony, electrical systems are extremely reliable, one reason for this being the use of redundant systems. The standards of design, workmanship, operation, and maintenance are not usually the result of poor job attitude on the part of the working crews. Rather, the degree of maintenance that can be provided by the utility is a function of availability of adequate funds. This quality assurance problem does impact electrical systems vulnerability. R&D into technologies can enhance the security of the systems and reduce vulnerabilities. For additional information on this question, I defer to the answer to the same question given by Mr. William A. Vaughn, Assistant Secretary of Energy for Environmental Protection, Safety and Emergency Preparedness in the Department of Energy.

North American
Electric
Reliability
Council

[redacted]
President

February 25, 1983

Mr. Ronald Williams
Subcommittee on Energy Research
and Production Staff
Committee on Science and Technology
U.S. House of Representatives
Suite 2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Williams:

On December 9, 1982 I was one of five panelists asked to testify before your House Subcommittee on Energy Development and Applications and Subcommittee on Energy Research and Development. The subject of the testimony was the Integrity of Electric Power Systems. After our synopsis of submitted prepared testimony, the panelists answered questions of the members present.

On January 10, 1983 we received additional written questions from the members. Although the member asking the question was not identified, it is assumed that the written questions are those of the members not present at the hearing. Our response to those questions is attached.

NERC has attempted to reach a consensus of the Regional Councils in answering these questions where possible and, where the question is in regards to a specific incident, the appropriate region has been consulted. In the event that your members should conclude that the answers provided are not responsive or if our answers should provoke further questions, we would be pleased to address their further concerns.

Sincerely,

[redacted]

Attachment

Research Park, Terhune Road, Princeton, New Jersey 08540-3573 • 609-924-6050

RESPONSES BY MICHEHL R. GENT
TO QUESTIONS OF THE SUBCOMMITTEE ON ENERGY DEVELOPMENT
& APPLICATIONS and the SUBCOMMITTEE ON ENERGY RESEARCH
& DEVELOPMENT

Question: In 1977, repeated acts of vandalism to a high voltage transmission system were perpetrated on the network from North Dakota across Minnesota, resulting in a $7 million loss to consumers. Were those responsible for the loss of some ten thousand insulators and 14 towers identified? What penalties were administered and to whom? Are those who organized and financed these acts of vandalism known? Is so, please identify.

Response: There were no penalties administered because no one was either arrested or charged with those criminal acts. Many of those familiar with this case have very strong feelings about certain individuals who we believe were involved in the destruction of the transmission line; however, sufficient proof to convict these individuals is not available.

Question: Does the Criminal Code Reform Act of 1981 adequately provide for federal intervention in acts of violence against public electric power production, transmission and distribution systems? What other legislation do you believe might be required?

Response: We believe that legislation (such as S-388), stipulating that it is a federal offense to perform criminal acts against electrical facilities involved in interstate commerce, would be appropriate. Other industry organizations, such as the Edison Electric Institute, have also actively supported such legislation.

Question: What provisions do you feel should be made (if any) for protection against electro-magnetic pulse interference with power transmission and distribution?

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Response: At present, there has been little dissemination of knowledge on this subject. The Department of Energy (Electric Energy Systems) has issued a request for proposals regarding a non-classified study on this subject. The Electric Power Research Institute is also reported to be considering such a project. Until these studies have definitely described the effects, the scope of the problem and possible protective measures, it is too early to take any position. We will be actively monitoring the studies as they progress.

Question: Do you know of any case where the FBI investigated an act of violence wherein such violence resulted in damage to a transmission or distribution system? If so please identify such a case (or cases).

Response: In December of 1980, a transmission tower, which is part of the 400 kV dc transmission line from North Dakota to Minnesota, was destroyed. The FBI investigated the destruction of this tower.

Question: What national plans exist for priority restoration of power in case of war or sabotage by foreign organized belligerents. That is, what plans have been prepared to specifically support hospitals, communication systems, sanitary systems, transportation systems, defense installations and critical industrial firms? Have such plans been distributed and agreed to?

Response: In the case of war or sabotage by foreign organized belligerents, national plans for priority restoration are the responsibility of the Departments of Energy and Defense. This would probably be administered through the Emergency Electric Power Executive Reserve Program. Each of the nation's electric utilities has a restoration plan that gives consideration to the critical facilities within its particular area. These plans consider both loss of capacity and energy supply due to acts of nature, interruption of supply and acts of war and sabotage. These electric utility plans are coordinated to the extent necessary at the regional council level.

October, 1979 — A Bonneville Power Administration 500,000 volt transmission line was put out of service because of insulator damage caused by gunfire.

December, 1979 — A bomb was placed in a Bonneville Power Administration substation near Lewistown, Idaho. The bomb, which fortunately failed to function, was of the type used by terrorist organizations.

Response: The Bonneville Power Administration reported that their Security Manager has been involved in all incidents of sabotage to the fullest extent of direct participation with low enforcement agencies in all investigations. Each of these incidents have had full FBI participation and investigation.

INCIDENT

October, 1979 — Six people were injured in an acetylene gas explosion in a Pacific Gas & Electric Company power plant. The explosion was blamed on sabotage.

Response: The Pacific Gas & Electric Company reports that PG&E did not experience this incident or a similar incident and cannot recall any such incident in an adjacent utility. However, PG&E did provide a brief summary of 74 bombings that have occurred between 1968 and 1980. It appears that none of the incidents involved a power plant but mostly substations and towers. The total estimated loss as a direct result of the bombings is estimated at $780,000 and the only fatality was an alleged bomber. Twenty-six of these incidents are claimed by five separate terrorist organizations. PG&E further reports that the FBI has participated in all of their bombing incidents and has been very cooperative.

In most instances sabotage and/or vandalism to major electric utility installations, be it generating station, switching station or transmission line, would have an adverse effect on the interconnected bulk power system, which in most instances would impact inter-state power flows. Therefore, the FBI should have a role in these occurrences, since their impact would be more than just within one state.

Question: Attached is a list of sabotage incidents which occurred in 1979 and 1980. Did anyone in your organization become involved in the investigations of any of these incidents? To what extent? Did anyone in your organization ever discuss any of these with the FBI?

Response: The regional councils were canvassed for responses to your selected list. Your ambiguous question "To what extent?" resulted in a variety of responses which will explain why some responses are more elaborate than others. In no case was the NERC staff or the related regional staff involved in the investigation.

INCIDENTS

March, 1979 Puget Sound Power and Light Company, serving the Seattle area, had a transformer damaged by gunshots. The incident interfered with service to several thousand customers and did about $40,000 damage.

July, 1979 Washington Water Power in Spokane lost 17 insulator discs on three power poles disrupting electrical service for three hours. The damage was caused by gunfire.

July, 1979 Pacific Power & Light, Jim Bridger 500 MW Unit-2 facility in Rock Springs, Wyoming, needed two weeks of repair when abrasive material was dumped into the unit's 6,000 gallon lubricating oil system during a six-week maintenance shutdown. Lost generation amounted to $3 million.

A list of the critical facilities and customers served by the utility is an integral part of a plan. Such a list aids in establishing priorities in restoration and includes such items as noted in the question plus police and fire fighting facilities, bulk fuel facilities and individuals with life support systems.

The extent to which these plans are available to the public varies. Because of the security implications, most utilities make them unavailable. However, in some instances, they are the subject of utility commission orders and considered public documents.

Question: In 1980, Attorney General Warren Spannaus of Minnesota said, "The FBI has ignored laws which clearly give them jurisdiction in such a case (meaning the vandalism against the 400-kilovolt transmission line built by the United Power Association; Elk River) and has claimed that vandalism is a local problem." Do you agree with the FBI or do you feel they should actively become involved in such matters?

Response: It was the contention of United Power Association that electricity which is transmitted across state boundaries is a product and thus is governed by the Interstate Commerce Commission. They contended that criminal acts against this affected the interstate trade and thus were under the jurisdiction of the FBI. This feeling was also shared by Minnesota's Attorney General, Warren Spannaus. However, the U.S. Attorney General held a different view. The FBI did not take jurisdiction or become involved in the destruction of the transmission line until the cooperatives transferred title of the transmission line to the Rural Electrification Administration (REA), thus making the transmission line federal property. Since the line was transferred to the REA, one tower was destroyed on December 30, 1980. The FBI did investigate the destruction of this tower.

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INCIDENT

October, 1979 — A Nebraska Public Power District transmission line tower for 345 kV alternating current (ac) line under construction was toppled near Chappell, Nebraska, after being repeatedly struck by a construction tractor.

Response: No one within Nebraska Public Power District became involved in the investigation of this incident. The incident occurred during construction while under the supervision and responsibility of the construction company who contacted the County Sheriff's office and State Patrol. The construction company indicated the incident was undoubtedly caused by a disgruntled employee.

The tower was toppled without line conductors attached and caused no electric outage. No known person within Nebraska Public Power District ever discussed this incident with the FBI.

INCIDENT

November, 1979 — Minnesota protesters appeared in Montana to generate opposition to transmission lines and encourage sabotage.

Response: We were familiar with the fact that certain individuals who protested the line in Minnesota appeared at meetings in Montana. From news coverage, their objective was to "teach the people in Montana how to stop the construction of transmission lines". It is not known if the FBI was involved.

INCIDENT

January, 1980 — Seven poles carrying a new 230 kV line in Kansas and owned by Central Kansas Power were found partially sawed through, in a scene which one observer found "frighteningly reminiscent of the recent television movie 'Ohms'".

Response: Midwest Energy Company (CKP merged) has submitted a response:

The actual cut on each of the poles was from 6 to 8 inches deep on a 16 inch diameter pole. The poles were repaired by bolting a plate approximately 8 feet long on the side of the pole where the cut was actually made. The cut was filled with a epoxy material and sealed to prevent further deterioration.

The final decision was made not to post a reward as we felt that the sooner the incident was forgotten the situation would stabilize. We had no further incidents of this type since that time on any line construction projects. The controversy and civil action on this property was settled without any further payment by Midwest. We would comment that it has been felt that it was an individual who may have had a personal grudge against the power company and felt that they were assisting the property owners over which we had purchased right-of-way.

INCIDENT

January, 1980 An apparent act of sabotage toppled an Arizona Public Service 500 kV transmission tower that will bring power from the Palo Verde Nuclear Generating Station west to Phoenix.

Response: On Janaury 8, 1980, a major incident took place at 355th Avenue and Salome Highway in which a $100,000 steel power structure was toppled by driving a caterpillar through one of the base legs. The Maricopa County Sheriff's Office was notified and the FBI was also involved with this incident. Total damage to the tower between $150,000 and $175,000.

INCIDENT

January, 1980 An apparent case of arson caused an estimated $18,000 in damage to a stockpile of Otter Tail Power Company line poles stored near

Mercer, North Dakota. The 15 poles were to be used for construction of the Underwood to Harvey transmission line.

Response: The following is a summary of this incident as related by Otter Tail Power Company.

Early in the morning of December 28, 1979, about 5:00 a.m., a fire was reported in our pole yard at Mercer, North Dakota. We had poles stored there for our Harvey-Underwood 230 kV line project. The fire started with an explosion that awakened the people who lived nearby. The fire departments from Mercer and Turtle Lake responded and put out the fire, but they had to use foam. The poles were treated with oil-borne pentachlorophenol, and water had little effect on the flames.

It was quite obvious that the fire had been started by an arsonist. There were about 125 poles in the yard at the time in about ten individual piles. The arsonist had poured gasoline on all the piles except one. Apparently he intended to destroy all the poles in the yard, but the explosion that occurred when he ignited the first pile probably scared him and he took off. Only one pole pile was destroyed, and that consisted of fifteen 950 foot poles. There was no damage to the other poles. To be sure we got the message, the arsonist left a sign propped up against one of the pole piles which read as follows:

"We have a canal in this county
Keep power lines out
Ho Ho Santa Claus"

The fire was investigated by the McClean County Sheriff's office and the state fire marshal, but the arsonist was never found. The general opinion of the authorities and the Otter Tail people involved was that the fire was started by a lone individual who was probably mentally disturbed and probably angry about the McClusky canal. The FBI was not notified about this incident, and they were never involved in the investigation.

INCIDENT

February, 1980

Thirty-five (35) wooden poles in "H-Frame" structure on Colorado-Ute's 115 kV transmission line serving the Durango area were partially sawed through in early February. Structures on about two miles of line had been vandalized and repair was scheduled for late February.

Response:

Colorado-Ute reports:

February, 1980

Thirty-five (35) wooden line poles, which made up 18 "H-Frame" structures of a 115 kV transmission line, were discovered to have been cut 2/3 of the way through. The line was located approximately 8 miles west of Durango, Colorado. The damage was discovered before the line collapsed and repairs were possible with the line standing.

The investigation of this incident was conducted by the Sheriff's Department, La Plata County, Colorado. Colorado-Ute's maintenance personnel provided technical information to the Sheriff's Department, but did not participate in the criminal investigation. There has been no formal contact between Colorado-Ute personnel and the Federal Bureau of Investigation. On October 23, 1980, sixty-three (63) poles making up 31 "H-Frame" structures and 1 angle structure of the same transmission line, were cut in a similar fashion. This time the approximate 3.2 miles of line came down. The poles were determined to have been cut with a hand saw. The damage on this section of line started with two structures east of the section found damaged on February 4th.

The investigation of this incident was also conducted by the Sheriff's Department, La Plata County, Colorado. Subsequent to the first incident, Colorado-Ute had employed a Director of Security who participated in the investigation of this second incident. Local agents of the Durango, Colorado FBI office

assisted the La Plata County Sheriff's Department and our Director of Security on an informal basis. The FBI could not participate on a formal basis due to a lack of jurisdiction.

INCIDENTS

February, 1980 — Arizona Public Service Company in Flagstaff had two poles sawed off - - putting a 12,000 volt electric line out of service.

April, 1980 — Arizona Public Service Company reported damage to a substation and the sawing of poles on a 230,000 volt transmission line. Both incidents occurred in the Flagstaff area.

Response: On February 26, 1980, two power poles were cut on the Santa Fe right-of-way located between Santa Fe Avenue and Phoenix Avenue in the city of Flagstaff, Arizona. Both poles were cut completely through with either a box saw or chain saw. One pole had the wording, "No nukes. Stop the death vendors." The other pole had, "Shut down Palo Verde now." Flagstaff PD notified of this matter and investigating.

The next related incident which occurred in reference to damaged power lines involved two 70' 230 kV transmission poles, which were sawed approximately 2/3 through the pole. This incident occurred just east of the Coconino Substation, Flagstaff area, sometime between April 14, 1980, and April 15, 1980. Damage to equipment was in the area of $10,000. The local Flagstaff Police Department was the investigating agency.

During 1982, Security had received information to the fact that the individuals involved with the incidents occurring at Flagstaff could possibly be identified through a reliable source. All information pertaining to the Flagstaff incidents has been turned over to the Police Department Detective Bureau, and they are presently investigating.

INCIDENT

November, 1977 to December, 1980 — For the past three years, vandals have repeatedly damaged the Cooperative Power Association-United Power Association ± 400 kV direct current line. Vandalism and security costs from the protest movement against the line now total $7,151,680.

Response: The preceding responses indicate United Power Association's involvement with the FBI during the period stated. Cooperative Power Association, a co-owner of the EHV-DC line has stated that they concur with United Power Association's responses.

INCIDENT

March, 1980 — Pacific Power & Light Company offered a reward for information leading to arrest and conviction of those responsible for vandalism of transmission lines in their Kalispell, Montana, district.

Response: Pacific Power & Light has no record of this incident, however, a similar situation occurred in August 1980 near Sheridan, Wyoming. At that time, Pacific Power offered a $10,000 reward. An informant collected the reward after the conviction of the two individuals named by the informant. The FBI was not involved.

Question: Since NERC is divided into several regional councils, is inter-utility coordination limited solely to these councils, or is there a well-defined mechanism for coordination among regional units?

Question: Is the cooperation within and among the regional councils limited to energy transfers through system inter-connections, or is there also a vehicle to make available resources required for restoration where they may be needed?

Institute (ANSI). In addition, a working relationship is maintained with all the major manufacturers of electrical equipment, and major architectual, engineering and construction firms.

Cooperation among the regions is not limited to energy transfers. One of the primary purposes of NERC remains to minimize outages of the bulk power supply system. Even though NERC's primary emphasis is on prevention, our industry's history shows that it has been able to shuffle men and equipment between regions to effect restoration of service when local resources have been depleted. Experience indicates that other electric systems are willing to furnish assistance to systems that have had their system disrupted by acts of the elements, equipment malfunction, accidents, sabotage or any other occurrences where the parties deem emergency assistance to be advisable. The EEI, APPA and NRECA all have mutual assistance pacts that have proved effective for restoration of service following serious damage to electrical facilities.

Question: In your written testimony, you mentioned improving systems integrity by reducing the number of control areas. Will you describe the legislative and institutional factors that inhibit this?

Response: A control area provides electronic control and regulation to the electric boundaries of one or more electric utilities during normal and emergency operation. In this modern time, this requires a state-of-the-art communication system. Because an effective communication system is the prerequisite to system security, it is my contention that security, integrity and an enhancement of the overall control function would be improved with a reduction in the number of control areas in America.

There are several factors that preclude this reduction, many of these being institutional or legislative. By this, I am referring primarily to the necessity to violate the principle of states' rights. Ideally established control areas would often cross states

Response:

Regional council boundaries have been established based on the close association and interaction of the electric utilities within those regions. The characteristics, planning criteria and operating problems of these utilities are generally common and as a result, inter-utility coordination is more active and well-defined within councils than among councils. However, this is not to imply that coordination does not exist among neighboring systems of adjoining regions, or among neighboring regions. Almost all councils have contractural agreements with neighboring councils which commit the parties to a continual examination of the present and future reliability of systems affecting the interface. The interregional studies involve analyses utilizing interregional load flows, inertial responses, transient stability studies, and other appropriate program packages appraise the ability of the interregional network to withstand representative severe contingencies without causing widespread cascading outages. The goal of these appraisals is to provide assurance that system developments and operating procedures within each Region, which could affect other Regions, are being properly coordinated. Studies are based on the most up-to-date plans of the individual systems. An analysis of any change in projected system development or mode of operation that will significantly affect interregional system performance is included in the appraisal report.

NERC is by no means the only national organization for coordination of electric utility activities. However, NERC has emerged as the core organization for issues affecting the reliability of the bulk power supply system. NERC and its committee structure maintains official liaison with the Edison Electric Institute (EEI), American Public Power Association (APPA), and National Rural Electric Cooperative Association (NRECA) through their participation in our Board meetings. NERC also has official liaison with such organizations as United Telecommunications Council (UTC), Institute of Electrical and Electronic Engineers (IEEE) and the American National Standards

lines. The process of integrating operations, when subject to several jurisdictions, has proved to be formidable. It has been done, but experience shows that it requires decades of negotiations and tremendous expense to satisfy the various political jurisdictions. It is not likely that many control areas, where several states are involved, will be merged in the future.

In the case of several utilities operating control areas within a single state there are still problems to be considered. Forming a single control area among several utilities generally means forming a power pool, which in turn means that participants must be willing to relinquish a certain amount of management prerogative in the control of their systems. A control area generally operates with a single control center that is responsible for unit commitment and economic dispatch of the generating units. In addition to the relinquishing of certain management control, there is the necessity of negotiating a written agreement among the participants that would address nearly every conceivable situation and resolve anticipated operating predicaments to the satisfaction of all. Any agreement of this nature falls under the jurisdiction of the Federal Energy Regulatory Agency (FERC) and is subject to the purview of nearly any interested party.

Despite these obstacles, utilities have been able to enjoy a majority of the economies normally available only through single control area power pools by extensive use and enhancement of their communication systems to relay the availability of economy energy. Our studies indicate that of 90% of the economies available through the exchange of "economy energy" are being routinely achieved. Over the past ten years, opportunities for savings through economy energy transfers have become available because of the evolving disparity of fuel costs. That is, the high cost of oil and natural gas as compared to coal and nuclear.

As an adjunct of these better communications, integrity has been improved. At the same time, since the bulk power transmission systems are loaded to the maximum extent with the delivery of economy power, the integrity has been compromised.

Question: In your written statement you suggested that it would be impossible for FEMA and DOE to develop a plan that would cope with problems caused by a loss of electricity. You also suggested that such a plan is not necessary. Will you explain then how various elements of government, such as the governors of two neighboring states combined with a city government, four counties, EPA, DOE, and the NRC might react under public and media pressure?

Response: As the question suggests, the problem is not how to handle the operation of electric systems, but rather how to handle the media. There are two stages to an emergency. For simplicity, stages of an emergency can be classed as, first, the immediate period, (the first instant to, say, the first day). The remainder of the emergency can be classed as the period in which the electric utility and those interested and affected parties mentioned have the luxury of time for gathering information, debating and taking action. The first requirement of the electric utility is to stabilize the electric system and restore it to the extent possible during the immediate period. Then, within each local area, the electric utility executes its plan for informing the local agencies, the media and the appropriate state governors and agencies. There are also required federal notifications.

During the second stage of the emergency, when there is time for assessment, it is envisioned that the capabilities of DOE and FEMA could play a vital role. DOE has demonstrated the facility of coordinating and communicating with NRC, EPA and the state energy offices. FEMA has the ability of working with other local, regional and national agencies. A generic plan is not necessary or possible because each emergency will be different and require

actions peculiar to that emergency and to the variety of geographic factors, load densities and the configuration of existing generation and transmission facilities.

In the past, the media has proved to be valuable in requesting the public to temporarily reduce its use of electricity during anticipated high use periods when generating facilities have become limited. This situation has generally involved the affected utility and the local media with the proper governmental agencies, local, state and federal all being notified. To my knowledge, this procedure has been effective and satisfactory to the agencies.

Question: What contingency plans do the utilities have for dealing with major coal and oil shortages?

Response: In 1980, the Department of Energy became concerned with this same issue. Attached to this response is our report to Assistant Secretary of Energy Sawhill. In summary, the report addresses utility and governmental responses to a postulated oil supply disruption. Even though our exposure to that type of disruption is much less today, the recommendations remain germane. One assumption involving our ability to respond is worth repeating - our response ability depends on the electric utility industry experiencing a prorata share of the curtailment. We have assured DOE that every electric utility has appropriately considered fuel supply disruptions in its emergency plans. That answer also pertains to utility pools and most councils.

Regarding major coal shortages, the actual plans for coping are similar to those for oil supply disruptions. Obviously, an interruption of coal supply affects different utilities than does an oil supply disruption. Since nearly all of our coal comes from domestic sources, America has far more control when the national interest becomes involved. In fact, coal supplies have been routinely disrupted over the decades with the strikes of the

various unions that affect the supply of coal - the miners and the rail workers. In the case of a coal miners' strike, the electric utility industry has coped by drawing on its stockpiles which, at certain times of the year, are often in excess of ninety days. Every few years, with the approach of negotiation time for the coal miners' contract, stocks have a tendency to creep up - only an extremely long, protracted strike, over three months, would have significant impact on our industry.

Rails are the principal mode of transportation for coal; and, a rail workers' strike is cause for concern also. Because other users of coal stockpile less coal, and because a rail strike affects nearly all commodities, the union is generally enjoined by a federal action long before electric utilities are seriously affected.

Question: Are the number of incidences over the past 10 years involving vandalism, sabotage, or other acts of violence against electric power production, transmission and distribution systems increasing, decreasing or remaining constant? Please provide statistics if you have them.

Response: We do not keep statistics which distinguish outages from acts of violence against electric systems from those outages that occur from acts of nature, equipment failure or operator error. Those incidences submitted with the question had little or no effect on the bulk power supply system.

Following several decades of declining cost, the cost of electricity has dramatically increased since the first oil embargo in the early 1970's as has the cost of most other goods and services. In addition, we have experienced a heightened environmental concern in the last 20 years. It is my observation that dissatisfaction with increasing cost and perceived environmental degradation has been manifested in several of the publicized and non-publicized sabotage incidents against electric utilities. Although I have no statistics, an informed guess is that

the number of incidents has increased. However, because our awareness and scrutiny has subsequently increased, it is possible that the frequency of incidents may not increase further.

Question: In reviewing the 1977 New York blackout, the Committee noted what may be an unusual number of equipment malfunctions which aggravated the situation and intensified the problem. Specifically:

1. An inadequately grounded transmission line tower in Westchester County;

2. Circuit breakers that failed to reclose after line fault (a loose locking nut resulted in a pressure drop in one circuit breaker and a disconnected closing circuit in another caused the malfunction);

3. An improperly designed circuit breaker opened at Indian Point 3 which disconnected the reactor from its load;

4. An improperly designed timer on the Hudson tie line caused a premature trip;

5. A bent relay contact on a 345 kV line caused the line to trip out on a temporary voltage surge;

6. An antiquated control room design in which confusion resulted in improper operation; and

7. Equipment undergoing maintenance that was not removed from the "ready list".

Are examples 1 through 7 accurate? Did the September 26, 1977 storm also disclose faulty equipment in the Consolidated Edison system? Is this condition typical; that is, does this level of required corrective actions exist in other utilities? Would it be fair to say these standards of design, workmanship, operation and maintenance are the result of a generally poor job attitude on the part of working crews? Is it poor supervision? Finally, how does this quality assurance problem impact electric systems' vulnerability?

Response: The following three pages, identified as 14-1, 14-2 and 14-3 constitute the response of Consolidated Edison Company.

Congressional Committee Document

Power System Reliability

The document identifies seven examples of equipment malfunctions which may have aggravated or intensified the events leading to the July 13, 1977 blackout. It should be noted that the causes of the blackout were clearly identified in reports published by Consolidated Edison, the New York Public Service Commission (Clapp Report) and the Department of Energy. The seven examples do relate to specific problems in the blackout reports, however, the description of the equipment malfunctions in some of the examples are incorrect. They are:

- Example 3 - There is not an improperly designed circuit breaker at Indian Point 3 which disconnected the reactor from its load. The arrangement of the Buchanan South Substation provides two outlet feeders for Indian Point 3 via circuit breaker no. 1 to feeder W97 and circuit breaker no. 3 to feeder W98. Since feeders W97 and W98 were both automatically and correctly removed from service because of a lightning strike to the common tower supporting them, Indian Point 3 was properly removed from service.

- Example 5 - The bent relay contact on a 345KV line caused the line to trip out on a temporary power surge not a voltage surge.

- Example 6 - The operation and design of the equipment in the control room were never identified as inadequate during the events leading to the blackout. Although additional indicators were added subsequent to the blackout to improve the information presented to the operators, the instrumentation and controls in the control room on July 13, 1977 were adequate to respond to any of the single events that occurred that night. It was determined that the unprecedented rapid series of events that evening made it difficult for the operator to analyze the data being presented to him.

- Example 7 - The gas turbine generators were undergoing post-shutdown maintenance and were not out of service due to equipment malfunction. Failure to remove them from the available category was an administrative shortcoming and even if they were properly recorded as unavailable, it would not have prevented the blackout.

A review of the September 26, 1977 incident, which contained an analysis of the performance of power system equipment, was submitted to Mr. Edward J. Fowlkes of the Federal Energy Regulatory Commission on March 27, 1978.

Con Edison cannot comment on the condition of facilities of other utilities. However, it is improper to say that Con Edison's standards of design, workmanship, operation and maintenance are a result of a generally poor job attitude on the part of working crews or supervision. Although equipment during both the July 13, 1977 blackout and September 26, 1977 incident did not operate correctly, it must be put in the proper perspective in relationship to the entire system. During these two incidents, Con Edison's facilities experienced unprecedented stress. Hundreds of relays, circuit breakers, transformers, feeders and automatic controls operated properly during the occurrences. This is indicative of the high quality assurance controls within the design, operation and maintenance organizations of Con Edison.

ELECTRIC ENERGY SUPPLY DISRUPTION CONTINGENCY PLANNING

Submitted To
Department of Energy Deputy Secretary
John C. Sawhill

Prepared By
The Ad Hoc Electric Power Emergency Planning Group

September 15, 1980

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FOREWORD

This report has been prepared at the request of United States Department of Energy (DoE) Deputy Secretary John Sawhill (Attachment 1) by the ad hoc Electric Power Emergency Planning Group. Due to the time limitations and the diverse nature of the electric utility industry, this report contains the suggestions and recommendations of the individuals serving as members of the ad hoc Group rather than the collective opinions or recommendations of the organizations they represent. However, the combined experience and expertise of the contributors to this report are sufficient to insure that the report's recommendations fairly reflect a consensus of the electric utility industry.

Rather than discussing contingency options associated with supply enhancement, demand restraint, and energy management as had been suggested, the ad hoc Electric Power Emergency Planning Group viewed the problem of an oil supply disruption from an industry perspective. The report therefore discusses problems associated with goal setting and model development, what can be done now, and what should and should not be done after an emergency has been declared.

It should be noted that the report's recommendations presume an equitable allocation of available oil supplies among the oil-consuming sectors (transportation, industry, residential/commercial, and electric utilities) during the disruption period and that there will be no other fuel availability or supply disruptions during the period of the scenario.

SCENARIO DEVELOPMENT

The DoE has requested that the Group base its response on a 5 million barrel per day (bbl/d) reduction of crude oil supply to the worldwide market. Considering the United States' (U.S.) commitment to the International Energy Agency (IEA), this could result in a crude oil supply shortfall to the U.S. of between 950,000 bbl/d and 2.4 million bbl/d. Based on an elementary analysis (Attachment 2) utilizing product ratios, the maximum reduction required of the electric utility industry to participate equally in the shortfall would be 170,000 bbl/d. To insure that this scenario is as definitive as possible, it has further been prescribed that the shortfall would begin on December 15, 1980 and last for six months.

The scenario was developed by the DoE along with the suggestion that the Group use the 1979 product mix ratios in determining the possible residual oil shortfall to the electric utility industry.

SUMMARY OF FINDINGS

Oil is expected to be used to produce nearly fifteen percent of the nation's electrical energy requirements in 1980. Eighty percent of this usage is concentrated in California, Florida, New England, New Jersey and the southeastern area of New York State. It is the opinion of the Group that the scenario considered — reduction under emergency conditions of the burning of 170,000 bbl/d for 6 months beginning December 15, 1980 — could be adequately handled - if the recommendations outlined in this report are implemented.

In preparing for a possible oil supply emergency, it would be prudent to expedite the operation of new nuclear and coal-fired units now. If an actual oil emergency occurs, such action would assist in alleviating its impact before it occurs. If there is not an oil emergency, this action would still reduce oil burn and reduce operating costs.

Any new generating units which can be made operational would contribute to the saving of oil on those utility systems which are large users of oil and would especially reduce the need for distillate oil for combustion turbines.

DIVERSE NATURE OF THE ELECTRIC UTILITY INDUSTRY

The diversity of electric utilities with respect to ownership, size, location and fuel mix makes it difficult to develop general or specific recommendations that could cover all situations. To every rule there could be an exception. Therefore, in the implementation of any rule or regulation that may be adopted, it will be prudent to consider each region or subregion separately with due consideration given to the basic objective. Further, it is essential that emergency plans, rules, and regulations be closely coordinated with the states and their public utility commissions and energy offices.

As previously indicated, the areas of California, Florida, New England, New Jersey, and southeastern New York State are of critical concern. The vulnerability of these areas to a 20% curtailment of fuel oil supply was examined by the NERC staff at the request of the Office of Management and Budget (OMB) in late 1978 and updated in May 1980 for a 35% curtailment assumption. These studies suggest Florida, New England and southeastern New York State, in that order, to be the most critical areas. Even if sufficient non-oil generation were available in other non-critical areas, the electric power transfer capability to Florida and New England would be a constraint at such extreme curtailment levels.

Recommendation:

Federal emergency plans should be tailored to accommodate specific regional and system characteristics. Further, the authority responsible for declaring an emergency, such as the President, should be advised of the importance of utilities implementing their pre-existing plans prior to formal declaration of an emergency rather than developing new plans which may not adequately address the diverse characteristics of individual regions and utility systems.

ESTABLISHING TARGETS

Attempts to establish macro level goals or targets for maximum allowed fuel oil burn by the electric utility industry are not recommended. Fuel oil, particularly distillate oil, is currently one of the most expensive sources of fuel for electric power generation and, therefore, a marginal source of supply in oil-dependent regions. As is the case with any marginal source, its use changes rapidly with relatively small changes in demand or alternate source availability. Additionally, there is a minimum amount required within each oil-burning region for area protection, start-up, flame stabilization and other non-substitutable uses.

Recommendation:

Any target established for reduced oil burn should be related to energy generation or oil consumption in excess of an appropriate threshold level below which reliability and adequacy of bulk power supply would be threatened. Such a threshold would provide a consistent basis for making trade-off decisions that minimize both oil burn and social disruption.

IMMEDIATE ACTIONS

Emergency Organization

Experience gained during previous disruptions should be utilized to the extent possible. The Group recognizes that the responsibility for actions relative to electric utilities during an emergency rests primarily with the management of the particular utility and that regulations dealing with such an emergency are generally within the purview of the states. The Group, therefore, cautions against action without the advice and counsel of those who must respond.

Recommendation:

> An Advisory Council should be established that could be convened as required and would be composed of the heads of several organizations (or their designees) that include NERC, EEI, APPA, NRECA, NARUC*, and the National Governors' Conference, with EPRI and NRRI* on call for technical support.

The Advisory Council, in conjunction with DoE/Economic Regulatory Administration (ERA), would formulate policies and develop actions to be taken in preparation for and during the supply disruption. NERC would be willing to assume the lead role in the Advisory Council, with specific responsibilities including communication with DoE/ERA, keeping the Advisory Council appropriately informed of all developments, decisions, and actions taken relative to the disruption, and convening meetings of the Advisory Council as required. NERC would also be willing to call on its Regional Reliability Councils for assistance.

To effect quick communication and response in the event of an actual disruption, NERC would take the lead in early industry notification. DoE/ERA and NERC would closely coordinate communications with the NERC Regional Managers and the other Advisory Council members. The NERC Regional Managers would employ a "tree" type notification procedure whereby each Manager would be in immediate communication with system personnel having operating decision authority through whatever pre-determined channels they see as most efficient. Reports of actions taken, oil used and estimated savings, up-to-date information on fuel inventory levels, and other data would feed back through this channel.

Oil Conservation Transfers

The DoE/Economic Regulatory Administration/Division of Power Supply and Reliability (ERA/DPSR) has instituted a monitoring program to audit, on a weekly basis, the effectiveness of the industry's efforts to conserve oil through the burning of alternate fuels and the subsequent transfer of that energy over the bulk power transmission grid to oil-burning regions. This program has been in operation for nearly two years and clearly demonstrates that the electric utility industry's efforts to maximize "coal-by-wire" have been most effective. These oil savings have currently plateaued at about 300,000 bbl/d. The industry and DoE/ERA are continuing in cooperative efforts to insure that this maximum level is maintained. As additional transmission lines are added to the network, this already impressive figure will tend to increase, at least for the period of the scenario under consideration.

*NARUC - National Association of Regulatory Utility Commissioners
NRRI - National Regulatory Research Institute

The few barriers to increased transfers that remain may be difficult to remove. Some state regulatory commissions have elected to interject "incentives" into the rate-setting process which may have the effect of causing a utility to generate its own energy rather than purchase lower cost energy. Also of increasingly significant importance are state "export taxes". When the economics of "oil displacement transfers" are artificially biased by such regulations, the oil-conserving transactions may not take place.

Recommendation:

The DoE should intervene, on behalf of electric utilities, with the states to allow the possible waiver of certain counterproductive "incentive" rate provisions, at least during the emergency period.

Substitution of Natural Gas

A) Many of the current temporary exemptions permitted by the Power Plant and Industrial Fuel Use Act of 1978 (FUA) allowing existing units to burn natural gas may soon expire. These exemptions generally run from eighteen to twenty-four months, and their expiration would be counterproductive in the face of an emergency.

Recommendation:

As soon as an emergency is anticipated any expiring exemptions should receive automatic extensions and applications pending approval be expedited. Electric utilities must be allowed to continue to burn natural gas to the extent it is available.

B) Natural gas displaces approximately 750,000 bbl/d during summer periods and 500,000 bbl/d in winter as a boiler fuel for electric generation. The summer-winter difference is due to the reduced availability of natural gas for electric generation during the winter season. This, in turn, is the result of increased winter demands of higher priority customers using gas principally for heating.

Recommendation:

During the type of emergency postulated, the priority of natural gas use for electric generation should be raised to the same level as industrial use.

Nuclear Programs to Minimize Impact of Petroleum Supply Disruptions

A) Several actions may be taken with nuclear programs to assist in minimizing the impact of a prolonged disruption in foreign petroleum supplies. The Group has been advised that the Three Mile Island Unit 1 (TMI-1) could be operated safely at its installed electrical capacity of 776 MW. TMI-1 originally achieved commercial operating status in 1974 and did operate successfully and dependably for four years. As an outcome of the accident at the Three Mile Island Unit 2, the Nuclear Regulatory Commission (NRC) has required special hearings prior to granting permission to restart Unit 1. The current schedule for legal review of TMI-1 restart places it beyond the scenario period. However, if this schedule were advanced, TMI-1 could play a significant role during the scenario period. TMI-1 could be restarted within a short period of time upon receiving permission to operate. For each day of full power operation, this unit would produce a quantity of electricity which, if produced by oil-fired facilities, would require up to 37,000 barrels of oil.

Recommendation:

TMI-1 plant should be licensed to operate at its installed electrical capacity of 776 MW in a manner consistent with health and safety standards.

B) Eight nuclear units are either fully constructed or nearly completed and could achieve full power operation in the 1980 or early 1981 period if full-power operating licenses are granted by the NRC on a timely basis. These are:

Unit Name/No.	Rating (Megawatts)	Scheduled Service Date[1]	Approximate Completion (%)[1]	NERC Region/ Subregion
Sequoyah 1	1,148	9/80	100	SERC
Salem 2	1,115	1/81	100	MAAC
Diablo Canyon 1	1,084	*	100	WSCC
McGuire 1	1,180	12/80	100	SERC
LaSalle 1	1,048	6/81	99	MAIN
Summer 1	900	6/81	95	SERC
Farley 2	807	12/80	90	SERC
Sequoyah 2	1,148	6/81	89	SERC
	8,430			

*Four months after NRC approval.

Sequoyah 1 and Salem 2 have their low power licenses, and are awaiting receipt of full power licenses. Licensing and construction of the remaining units has already been noted by DoE/ERA as being important in assuring a reliable energy supply and in providing for a significant reduction of fuel oil consumption ("Electric Power Supply and Demand for the Contiguous United States 1980-1989", July 1980).

Not all of these units are located in heavily oil-dependent areas. However, if these units are licensed and operating at full power, they would, under many conditions, be able to displace significant quantities of oil.

A discussion of the NRC licensing actions and legislative constraints to the issuance of operating licenses is provided in Attachment 3.

Recommendation:

Licensing of these units should be expedited.

C) Several NRC regulatory requirements for operating reactors may result in shutdowns if presently established compliance dates are not achieved. Specific regulatory items involved include emergency planning, fire protection and certain TMI-related requirements on operating personnel training, emergency communication plans, upgrading of coolant systems, and monitoring instrumentation. DoE/ERA has been working closely with NRC in reviewing compliance dates with respect to their impact on oil consumption and reliability.

[1]Source: "Coordinated Bulk Power Supply Program (ERA-411) Reports," April 1, 1980, updated by discussions with NERC Regional Reliability Councils.

Recommendation:

The NRC should continue to work closely with DoE/ERA in examining alternatives that would result in compliance date extensions consistent with national goals.

Expedite Start-Up of Coal-Fired Units

There are twenty-seven coal-fired units with a total capacity of approximately 13,000 MW scheduled for start-up in late 1980 and early 1981. Much of this new coal-fired capacity would be located in areas that now use oil to fuel electric generation.

With the interregional transmission facilities now being loaded to near maximum potential for the purposes of oil conservation, those coal units in oil-fired regions scheduled for 1980 and early 1981 start-up are most critical.

Recommendation:

The licensing and start-up of the following eleven units, located primarily in oil-burning regions, should be expedited:

Unit Name/No.	Rating (Megawatts)	Scheduled Service Date[2]	NERC Region/Subregion
Sandow 4	545	4/81	ERCOT
Indian River 4	400	9/80	MAAC
Deernaven	235	2/81	SERC/FL
Roxboro	720	9/80	SERC/VACAR
Nearman 1	235	10/80	SPP
Big Cajun 2-1	540	9/80	SPP
Northeastern 4	450	9/80	SPP
Sooner 2	515	10/80	SPP
Big Cajun 2-2	540	12/80	SPP
White Bluff 2	740	5/81	SPP
Grand River Dam Authority	490	5/81	SPP
	5,410		

[2]Source: "Coordinated Bulk Power Supply Program (ERA-411) Reports," April 1, 1980, updated by discussions with NERC Regional Reliability Councils.

New Transmission Facilities

Under the given scenario, little can be done about beginning construction of any transmission line that could be effective in assisting during the disruption, or about major re-scheduling of any line now in early stages of construction. However, critical lines scheduled for completion during the disruption period — such as Hosensack-Elroy 500 kV (MAAC) — should be monitored closely to avoid delays and to expedite any remaining required approvals.

Recommendation:

The DoE/ERA should continue to assist in the removal of impediments to the timely completion of construction.

Review of Environmental Constraints

On an emergency basis, certain environmental restrictions to the operation of existing coal - and oil-fired powerplants could be suspended. This would have the effect of both enhancing coal-fired generating capacity and of allowing the substitution, in a number of powerplants, of more easily obtainable higher-sulfur oil for lower-sulfur oil. A more detailed discussion is affixed as Attachment 4.

Recommendation:

The following measures are recommended for consideration or endorsement by the DoE:

Regulatory Action

1. Section 110 (f) of the Clean Air Act Amendments of 1977 provides that the Governor of a state may petition the President to declare that a national or regional energy emergency exists. If the President declares such an emergency, the Governor may, upon certain conditions, issue a "temporary emergency suspension" of any part of an applicable State Implementation Plan (SIP) for up to four months. A SIP suspension under Section 110 (f) could have the effect of allowing substitution in power plant boilers of higher-sulfur oil, or in a limited number of cases, coal for low-sulfur oil.

2. The Administrator of the Environmental Protection Agency (EPA) could immediately approve, pursuant to Section 110 of the Clean Air Act, all pending SIP revisions that would authorize increased hours of powerplant operation or operation at higher capacity.

Legislative Actions

3. Emergency legislation could be passed authorizing suspension of SIP provisions in cases of a national energy emergency similar to the authority contained in Section 110 (f), except that the adverse effects of the emergency would not have to occur in the vicinity of the powerplant for which the SIP requirements were being waived. This would result in increased generation of electricity at coal-fired units by, among other things, allowing de-rated plants to operate at full capacity.

4. Emergency legislation could be passed authorizing temporary suspension of applicable New Source Performance Standards (NSPS) requirements. This would have the effect of permitting by-pass of emissions control equipment required by NSPS, thus increasing available generating capacity.

5. Emergency legislation could be passed authorizing temporary suspension of Prevention of Significant Deterioration (PSD) requirements. The same effect would be achieved as in number 4 above.

6. Emergency legislation could be passed that would suspend applicable federal thermal effluent limitations and federally approved state water quality standards. In many cases this would allow by-pass of cooling towers, where feasible, and thus increase available non-oil-fired generating capacity.

7. Emergency legislation could be passed suspending, on a selective basis, effluent limitations and water quality standards that require the use of energy intensive control technologies.

8. Strongly pursue initiatives to assure that the transportation of coal is not impeded where it is otherwise practical and economically feasible.

The above legislative actions do not address otherwise applicable state and local requirements. Presumably, emergency legislation preempting, on a temporary basis, similar state and local environmental statutes and regulations could be enacted consistent with the 10th Amendment.

Energy Emergency Plans

Emergency plans have been developed and tested over the years. Coping with capacity deficiencies is entirely within the province of the electric utility industry. However, a fuel supply disruption of any type, particularly oil, will affect every sector of society and, therefore, cannot be handled totally within the electric utility industry. As essential as electric utility system and power pool energy emergency plans are, they will be largely ineffective unless they are fully integrated with the appropriate federal, state and local plans and other energy user plans.

Certain elements of individual emergency plans are discussed later. However, it is important to recognize that electric utilities are proportionately very small-volume users of oil and that no amount of curtailment of electric utility use can totally mitigate the need to reduce consumption in other sectors. Should it ever become necessary for electric utilities to place all of the many steps of their energy emergency plans into effect, there will be no way to totally avert the accompanying undesirable side effects. In view of the preceding, it is imperative that an emergency as described by the scenario be prevented from disproportionately affecting oil deliveries to electric utilities.

Recommendations:

The DoE/ERA should assist in integrating the various elements of local, state and regional energy emergency plans including those of the electric utilities. It is anticipated that such plans must address enforcement and policing of measures mandated by appropriate authorities.

ACTIONS DURING AN EMERGENCY

Even though this scenario is definitive, in reality, should an event occur that would lead to a worldwide shortage of oil, there would be no way of predicting the duration and no way to guarantee that the situation would not get worse.

Very few options are available during an oil supply disruption beyond those currently being employed as a matter of normal prudent operation. It is the hope of this Group that during a national emergency, national solutions will be applied for the maximum overall benefit, and load curtailment, if necessary, will be mandated as appropriately and equitably as possible.

Those options which are available may have undesirable side effects, especially if they are required for a long period of time. While it is understood that a number of actions might be initiated simultaneously, the suggested actions listed below are ranked to correspond to increasing severity of supply disruption:

Curtailment of Utility Internal Usage

Although this action yields only about 0.2% reduction in total utility demand, it is typically one of the first taken by utilities in an energy emergency, preceding any requests for customer curtailment, thereby demonstrating utility "good faith" and commitment.

Maximum Utilization of Hydro Generation

This will require the maximizing of hydro use to save oil by neglecting generally desirable goals, such as maintaining lake levels needed for recreational use or maintaining water conditions down stream.

Emergency Electric Energy Imports From Mexico and Canada

Increased deliveries of non-firm electric energy to the U.S. from Mexico and Canada may offer some potential for displacing oil during a U.S. supply disruption.

Recommendation:

During emergencies, deliveries of non-firm electric energy to U.S. systems from Canada and Mexico to displace oil should be increased where feasible. DoE/ERA should continue to assist those utilities having interconnections with Canadian or Mexican systems in arranging for such increased deliveries.

Bypassing of Energy Consuming Pollution Control Equipment

Energy consuming pollution control devices such as scrubbers should be bypassed if significant amounts of oil can be conserved without endangering the equipment.

Emergency Ratings

Units can generally be operated 5%-6% above their normal operating capacity for short periods of time (a few hours) in an emergency situation. Since operation at this higher level decreases the expected life and efficiency of the equipment, it is seldom used.

During a relatively long-term emergency situation, it might be appropriate to utilize these emergency ratings for short periods of time (one to three hours) for meeting daily peak loads if such use would avoid the use of oil burning combustion turbines. Since it would be applied only to coal-fired units, a maximum 1% increase in total capacity for only 10% of the daily cycle might be realistically achieved.

Public Appeals

Through the news media, the message should be disseminated to the public that an energy crisis had developed, and each consumer asked to use no more electricity than is essential. These appeals would suggest such actions as reduced thermostat settings in the winter, turning out lights where feasible, and washing dishes by hand.

Generally, during short-term emergencies, public appeals have been very effective when the public has been adequately informed. However, because the average consumer does not make the connection between electricity use and oil, the continued effectiveness of public appeals as an electric energy reduction measure during an oil supply disruption is questionable.

Recommendation:

Continuous communication with the public is essential, and may be the most important element of any energy emergency plan. However, do not presume that the continuous use of public appeals will effectively reduce electric consumption over an extended period.

Government Mandated Curtailments

This step in load management would require action by the responsible governmental authorities. Mandated curtailment of load could include the elimination of outside lighting, limited hours for shops and commercial establishments, reduction of non-essential industrial loads, and enforced reduction of thermostat settings in all structures. These procedures are effective in reducing energy usage, but very unpopular with those whose earnings are affected by the measures. Effectively implemented, mandated measures may be the final step required to compensate for the oil deficiency. While interruptible loads would fall within this category, they are of value mostly for capacity shortages and thus should not be counted on for the conservation of energy.

Rotating Blackouts

The most severe step which may be taken is to curtail firm load on a rotating basis according to procedures outlined in the individual utility's "energy emergency plan". It may be more effective to curtail large customers, such as industrials, before resorting to rotating outages of residential customers. It must be recognized that rotating blackouts may result in severe economic and public safety consequences.

Because of its severity, utilities would be most reluctant to institute this measure. Its effectiveness lies chiefly in reducing instantaneous demand, although there obviously would be a reduction in energy as well. Public acceptance would be reasonable during extreme weather, when the consumer might anticipate power shortages. However, if used on a routine basis over a period of time, public acceptance would likely decrease and the effectiveness of rotating blackouts lessened as customers adjust their time-of-use patterns. Rotating blackouts should be reserved for a severe crisis and not used as an energy conservation measure for an extended time.

OPERATIONAL MEASURES "NOT" RECOMMENDED

Several measures or actions are often suggested that are merely capacity relief measures. Based on the given scenario that the fuel supply interruption will be for a duration of six months, this Group makes the following recommendations:

Mandating Increased Oil Conservation Transfers

As discussed earlier, electric utilities, in conjunction with DoE/ERA have been working to insure that "coal-by-wire" energy transfers are maximized. While increasing these transfers during an emergency may appear desirable, sound system operating practices, especially relative to safe transmission line loadings and area protection, should not be violated. The operation of the electric systems to maximize oil conservation by energy transfers while maintaining system reliability should remain the province of the electric utilities themselves.

Recommendation:

Do not mandate or otherwise attempt to force increased oil conservation transfers.

Deferral of Planned Maintenance

Outages for scheduled maintenance are normally subject to many adjustments due to continuously changing circumstances. In the event of an oil emergency, electric utilities — accustomed as they are to handling emergencies — would, with sufficient notice and of their own volition, make prudent adjustments to their operations to assist other utilities. Such adjustments must consider the risk of exposure of system facilities to future outages.

Recommendation:

Do not advocate the deferral of maintenance that would expose equipment to unnecessary future outages.

Voltage Reduction

The effectiveness of voltage reduction is subject to controversy. Experiments on some systems indicate this is a viable technique to save energy; experiments on other systems refute this position. As a public relations tool for emphasizing the need for energy conservation, voltage reduction obviously has merit. Lacking convincing arguments in favor of the effectiveness of voltage reduction, however, and considering the results of the somewhat limited research, voltage reduction as a means for saving energy is suspect. While it would probably be employed on most systems as the "first step," it would be more of a placebo than a cure.

Recommendation:

Do not advocate voltage reduction as an effective means of saving energy. It would be most proper to reserve this tool to be used at the discretion of each utility system and only for short-term capacity relief if it becomes necessary.

Curtailment of DoE's Uranium Enrichment Operations

The uranium enrichment facilities of the DoE are major energy consumers, requiring up to 7,500 MW when operating at full capacity. In the past, the temporary curtailment of this operation has played a large role during capacity shortages. Since there is a relatively large stockpile of enriched uranium at this time, these plants could be operated at a floor capacity level to decrease energy consumption by several thousand megawatts. However, the current operation and planned operation for the remainder of 1980 and 1981 are at the floor capacity of about 2,600 MW. No significant reduction can be achieved without experiencing a cold shutdown of a major section of the plant, with inherent significant equipment degradation followed by restart costs of several hundred million dollars and some doubt about whether a restart could be achieved. Since its initial operation, the plant has remained hot without a shutdown of major segments because of this inherent freeze-up and restart problem. Therefore, significant power savings are not achievable at the uranium enrichment facilities during the time period under consideration.

Recommendation:

Curtailment of the DoE's uranium enrichment facilities should not be considered since it will not contribute to the solution of this scenario.

LIST OF ATTACHMENTS

Attachment 1: Letter John C. Sawhill to Walter D. Brown dated July 24, 1980 with attachment and response by Walter D. Brown accepting, dated July 30, 1980.

Attachment 2: Work sheet on fuel consumption.

Attachment 3: Discussion of NRC licensing actions and legislative constraints.

Attachment 4: Discussion of Elimination on Emergency Basis of Environmental Constraints Limiting Operation of Power Plants.

Attachment 5: NERC Map

ATTACHMENT 1
(six pages)

Department of Energy
Washington, D.C. 20585

24 JUL 1980

Mr. Walter Brown
President
National Electric Reliability Council
Terhune Road
Princeton, New Jersey 08540

Dear Mr. Brown:

The Nation continues to be dependent on imported crude oil and petroleum products to satisfy a large portion of its energy needs. Associated with this dependence is the high risk to the Nation's economy and security in the event of an energy supply interruption. Thus we must strive to improve our national emergency preparedness program to cope with energy shortages.

The electric utility sector represents an important segment of our energy supply system and can play a vital role, in cooperation with the Government, in minimizing the impacts of any disruption in petroleum or other energy supplies. Your management and technical expertise in electric power generation would be invaluable to our contingency planning efforts.

I request that the National Electric Reliability Council, along with the other utility organizations, American Public Power Association, the Edison Electric Institute, and the National Rural Electric Cooperative Association, participate as a member of an ad hoc Electric Power Emergency Planning Group to assist the Department of Energy in its effort to develop the set of plans and management relationships necessary to improve our national emergency preparedness.

We recognize that the utilities, as operating units, have the responsibility to carry out response actions during an actual emergency. Therefore, it is suggested that the electric utility industry assume appropriate responsibility, in cooperation with the Department, for planning and coordinating industry/government contingency actions in the event of an energy interruption. This group would also seek to identify what legislative and regulatory initiatives would be needed to facilitate operations during an emergency.

Such contingency options could be identified in three general categories: supply enhancement, demand restraint, and energy management or substitution.

We visualize that the effort will need technical assistance and coordination. We suggest that the ad hoc Electric Power Emergency Planning Group may wish to request such assistance from the Electric Power Research Institute. In addition, I would hope that EPRI might assist the Department and the ad hoc Planning Group in its initial effort to develop a set of workable response options for the electric utility sector in response to a sudden curtailment of oil supplies. We are writing simultaneously to Floyd W. Lewis, Chairman of the Board of Directors, about EPRI's possible contribution to the ad hoc Electric Power Emergency Planning Group, presuming that it will be formed. A copy of my letter to Mr. Lewis is attached. Our target for this initial effort is September 15, 1980.

We are also calling on others in the energy industry, such as the National Petroleum Council, to assist us in this very important undertaking. Effective energy emergency preparedness requires the support and cooperation of industry and Government.

I urge you to give this matter your immediate consideration and request that you designate a member of your staff to serve as a point of contact in this effort. I have designated Barton R. House, Deputy Administrator, Operations and Emergency Management, Economic Regulatory Administration, to coordinate the Department's overall contingency planning activities. He can be reached at (202) 653-3410.

Thank you for your cooperation.

Sincerely,

John C. Sawhill
Deputy Secretary

Enclosure

cc: American Public Power Association
Edison Electric Institute
National Rural Electric Cooperative Association

Department of Energy
Washington, D.C. 20585

JUL 18 1980

Mr. Floyd W. Lewis
Chairman, Board of Directors
Electric Power Research Institute
C/O Middle South Utilities, Inc.
P. O. Box 61005
New Orleans, Louisiana 70161

Dear Mr. Lewis:

The Nation continues to be dependent on imported crude oil and petroleum products to satisfy a large portion of its energy needs. Associated with this dependence is the high risk to the Nation's economy and security in the event of an energy supply interruption. Thus, we must strive to improve our national emergency preparedness program to cope with energy shortages.

The electric utility sector represents an important segment of our energy supply system and can play a vital role, in cooperation with the Government, in minimizing the impacts of any disruption in petroleum supplies. I am asking the American Public Power Association, the Edison Electric Institute, and the National Rural Electric Cooperative Association to form an ad hoc Electric Power Emergency Planning Group to assist the Department in its efforts to develop plans and management relationships necessary to improve our national emergency preparedness in the electrical sector. I have suggested that the ad hoc Planning Group may wish to request technical assistance from the Electric Power Research Institute in this effort. I would hope that EPRI might assist the Department of Energy in its initial effort to develop a set of workable emergency response options for the electrical power sector. Our target for this initial effort is September 15, 1980. To this end, I ask for your approval to have EPRI participate in this important activity, as the technical analysis arm of the Emergency Planning Group.

We recognize that the utilities, as the operating units, have the responsibility to carry out response actions during an actual emergency. Therefore, it is suggested that the electric utility industry assume appropriate responsibility, in cooperation with DOE, for planning and coordinating industry/government contingency actions in the event of an energy interruption. This group would also seek to identify what legislative and regulatory initiatives would be needed to facilitate operations during an emergency.

Such contingency options could be identified in three broad categories: supply enhancement, demand restraint, and energy management or substitution.

We are also asking other segments of the energy industry, such as the National Petroleum Council, to assist us in this very important undertaking. Effective energy emergency preparedness requires the support and cooperation of industry and Government.

I urge you to give this matter your immediate attention. I have designated Barton R. House, Deputy Administrator, Operations and Emergency Management, Economic Regulatory Administration, to coordinate the Department of Energy's overall domestic contingency planning activities. His telephone number is (202) 653-3410.

Thank you for your cooperation.

Sincerely,

John C. Sawhill
Deputy Secretary

cc: American Public Power Association
Edison Electric Institute
National Rural Electric Cooperative Association

NATIONAL
ELECTRIC
RELIABILITY
COUNCIL

July 30, 1980

Mr. John C. Sawhill
Deputy Secretary
DEPARTMENT OF ENERGY
1000 Independence Avenue, S.W.
Washington, D.C. 20314

Dear Mr. Sawhill:

I have received your letter of 24 July 1980 suggesting that the electric utility industry assume appropriate responsibility, in cooperation with the Department, for planning and coordinating industry/government contingency actions in the event of a petroleum supply interruption. At a meeting, Friday, July 25, 1980 in Washington, of parties receiving similar letters and your Mr. Barton R. House, an ad hoc Electric Power Emergency Planning Group was established. For this group's initial effort, the consensus of those in attendance was that the National Electric Reliability Council should provide the lead role for the industry. We have accepted that role and are proceeding with the task.

Even though our industry uses only 8.9% of all refined products supplied in the United States, a disruption in that supply would certainly pose a threat to the Nation's economy and security. We, therefore, understand the initial goal of our Electric Power Emergency Planning Group to be to develop plans (relative to the electric utility industry) that should be effectuated in the event of a sudden curtailment of petroleum supplies. We also understand that our target date is September 15, 1980.

The composition of this ad hoc Electric Power Emergency Planning Group appears now to be:

Walter D. Brown
President
National Electric Reliability Council (NERC)
Research Park, Terhune Road
Princeton, New Jersey 08540
(609) 924-6050

Richard Rudman
Division Director, Policy Planning
Electric Power Research Institute (EPRI)
P. O. Box 10412
Palo Alto, California 94303
(415) 855-2134

Justin D. Karp	Vice President Edison Electric Institute (EEI) 1111 19th Street, N.W. Washington, D.C. 20036 (202) 878-7464
Alex Radin	Executive Director American Public Power Association (APPA) 2600 Virginia Avenue, N.W. Washington, D.C. 20037 (202) 333-9200
C. A. Robinson, Jr.	Deputy General Manager National Rural Electric Cooperative Association (NRECA) 1800 Massachusetts Avenue, N.W. Washington, D.C. 20036 (202) 857-9500

We are pleased to have this opportunity to work with Mr. House on this timely and important task. Should I not be available, Mr. M. R. Gent of my staff will act in my behalf.

Sincerely,

Walter D. Brown

Walter D. Brown
President

MRG:lr

cc: Mr. Richard Rudman
Mr. Justin D. Karp
Mr. Alex Radin
Mr. C. A. Robinson, Jr.
Mr. C. E. Winn
Mr. Barton R. House

ATTACHMENT 2

ELECTRIC POWER EMERGENCY PLANNING
FUEL OIL CONSERVATION STATISTICS

A. Based on 1980 data through July 25th:[1]

1. Residual oil supplied averages 14.6% of the total products supplied.

2. Imports account for 35.4% of residual oil supplied.

3. For the four-week period ending July 25, 1980, U.S. refinery production represented 72.9% of total oil products supplied (12,100,000 bbl/d of 16,600,000 bbl/d).

4. For the same four-week period imports accounted for 36.5% of total crude oil supplied (4,992,000 bbl/d of 13,692,000 bbl/d).

B. Based on 1979 data:[2]

In 1979, electric utility use represented 48.4% of total residual oil consumption (1,351,000 bbl/d of 2,792,000 bbl/d).

* * * * * *

Since the electric utility industry uses 48.4% of total residual oil, and residual oil comprises 14.6% of total products supplied, utility residual oil use represents 7.07% of total products supplied (.484 x .146). An equitable conservation participation effort would thus require that utilities reduce their usage of residual oil by 7.07% of the total products flow which is interrupted. Applying this percentage to several total product interruption levels yields the following:

Total Product Interruption to U.S. (million barrels per day)	Utility Residual Oil Use Reduction (million barrels per day)
1.000	.071
1.250	.088
1.500	.106
1.750	.124
2.000	.141
2.250	.159
2.500	.177
Proposed Scenario:	
2.400	.170

[1] Energy Information Administration Weekly Petroleum Status Report, August 1, 1980; DoE/EIA - 0203 (80-31)

[2] Energy Data Report; DoE/EIA - 0181 (79)

August 12, 1980

ATTACHMENT 3
(ten pages)

TO: Edison Electric Institute

FROM: LeBoeuf, Lamb, Leiby & MacRae

SUBJECT: Expediting Near Term Operating Licenses for Nuclear Power Plants

Introduction

The Department of Energy has asked for EEI's assistance in minimizing the impacts of any disruption in petroleum supplies. Specifically, the Institute is to identify what legislative and regulatory initiatives would be needed to facilitate operations during an emergency and to reduce the consumption of oil during the period September 15, 1980 through June 15, 1981 by 1.6 million barrels per day.

One way of satisfying this goal would be to expedite the licensing of those nuclear power plants which have completed their construction and pre-operating license requirements and are ready to begin substantial power operation during that time.* Based upon discussions with

* A second way is to expedite licensing of those plants which have already operated and which are undergoing licensing review prior to restart. A third way is to defer regulatory action which could cause additional plants to shut down or reduce power (e.g., the NRC's recently approved emergency planning rule and its proposed fire protection rules for plants operating prior to January 1, 1979 (45 Fed. Reg. 36082, May 29, 1980)). The NRC could, for example, carefully review its current requirements for operating plants (e.g., those pertaining to training and qualification of reactor operators) and either revise the requirements or postpone the implementation dates. See "NRC Action Plan Developed as a Result of the TMI-2 Accident" (NUREG-0660, Vols. 1 and 2, May 1980).

EEI staff we understand that 8* nuclear units may potentially be ready for full power operation during the period in question. However, due to delays inherent in the existing NRC administrative and regulatory regime, certain legal requirements under the Atomic Energy Act of 1954, as amended ("the Atomic Energy Act"), the National Environmental Policy Act ("NEPA") and other Federal and state laws, these units may not add substantially to the energy base in the near term. The analysis which follows is based on the assumption that (a) changes in the national energy picture crucial to the welfare of this nation, both economically and militarily, will require a relaxation of current Federal restraints to issuing operating licenses, including those resulting from the incident at Three Mile Island, without compromising essential safety and long-term environmental objectives; and (b) that the Nuclear Regulatory Commission will be responsive to these developments in its administration of the applicable laws.** This memorandum therefore focuses on the legislative and regulatory changes that are necessary to expedite near-term licensing of operation of completed plants.

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* North Anna 2, Sequoyah 1, Salem 2, Farley 2, McGuire 1, Diablo Canyon 1, LaSalle 1, Summer 1.

** This implies that the NRC and its staff will apply NRC regulations, Regulatory Guides and associated documents such as the Standard Review Plan so as to minimize unneccesary delay.

In completing this analysis, we assume that the units in question would be capable of achieving substantial power operations within the period of time under consideration absent administrative and regulatory constraints. We recognize that it is sometimes difficult to determine the cause of delays and the relationship of "licensing delays" with such matters as unavailability of materials, labor difficulties, etc. Moreover, this analysis will only address delays attributable to Federal requirements.* Often the causes of delay are actions by state and local governmental entities. To ensure that operation of nuclear power plants is not impeded by conflicting State and local requirements, Congress would have to enact preemptive legislation beyond anything contained in the Atomic Energy Act.

Overall reform of nuclear power reactor regulation (including improvement in NRC management of its responsibilities) is beyond the scope of this memo. The great bulk of the delay in licensing operation of nuclear power plants is due to problems which are rooted in the earlier stages of licensing. Thus, the long-term solution to rapid development of nuclear generated power must address these earlier phases, for example, by standardization of plant design,

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* It is assumed that Federal agencies other than the NRC such as the Corps of Engineers and EPA are not causing delay and that any necessary state action under the Clean Water Act has occurred.

early site selection, and public participation in the initial phases of the licensing process, all to the end that crucial problems concerning siting, design and need for the plant are resolved before substantial sums are committed to construction.

Discussion

A. Legislative Requirements

A major legal obstacle to the issuance of near-term operating licenses is the requirement of section 189 of the Atomic Energy Act that NRC hold a hearing, if one is requested, on the issuance of the license. Because the NRC's jurisdiction includes health and safety, common defense and security and environmental matters, the types of issues which may be considered in the hearing can be extremely broad. The TMI accident raised a host of safety issues which have yet to be resolved in adjudicatory proceedings. These facts, coupled with the scope of the operating license review at least as perceived by the NRC,* guarantee that major opportunities for delay are presented to persons who desire to prevent the operation of additional

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* Cf. Boston Edison Co., et. al., Denial of Petition for Rulemaking (Docket No. PRM-51-4), 45 Fed. Reg. 10492, Feb. 15, 1980.

nuclear power plants. In fact, it is not feasible for the opportunity for obstruction to be substantially reduced without legislation, due to the interplay of the Atomic Energy Act, NEPA and the Administrative Procedure Act.

Several legislative initiatives could be taken to address this problem. A relatively straightforward proposal, and one which would likely have the greatest likelihood of removing hearing obstacles in the near-term, would be to amend the Atomic Energy Act to authorize the NRC to issue an interim operating license prior to completion of any hearing. The Commission would consider written comments from any person prior to taking such action as well as all other information available to the Commission and would issue its decision within a short period after receiving an application for an interim license. Prior to issuing the interim license, the Commission would have to find that the public health and safety and the environment would be adequately protected during interim operation and that the public interest warranted the license. The authorization would be appropriately conditioned and would expire after 12-18 months unless extended for good cause. The Commission's decision to grant the license might or might not be subject to judicial review as otherwise provided in the Atomic Energy Act.

Other legislative approaches could also improve the present situation. For example, the Atomic Energy Act could be amended to limit the scope of the Commission's review at the time of issuance of an operating license; to limit sharply the issues which could be considered in an operating license hearing; and to specify that the issuance of the construction permit--not the operating license--is the major Federal action involved in licensing of a nuclear power plant. In addition, the Atomic Energy Act could be amended to bar the NRC from reviewing the environmental effects or costs of intake or discharge structures or parameters. Finally, the potential for state actions created by the 1977 amendments to the Clean Air Act could be repealed.

B. Regulatory Requirements

Short of legislation, there are a number of regulatory changes that could prudently expedite operating licenses. These fall into three basic categories:

(a) health and safety

(b) environment

(c) financial qualifications and the hearing process.

With respect to health and safety oriented regulations, the Commission could modify the soon to be published emergency

planning regulations (10 C.F.R. §§50.33, 50.47, 50.54 and Appendix E) to extend the implementation date for the rule from April 1, 1981 to some more realistic date. In addition, the implementation date for the 15 minute public notification capability could be extended beyond July 1, 1981. Finally, the date for submitting implementing procedures for emergency plans could be extended for a reasonable period after full power operation is authorized (Proposed Appendix E, section V). Of course, other changes in the rule could be made along the lines proposed by EEI and AIF in their presentation to the Commissioners on June 25, 1980.

The NRC's "TMI-Related Requirements for New Operating Licenses" (NUREG-0694), June 1980 sets forth an array of requirements and actions which the NRC has approved for new licenses. These fall into the following categories:

(1) those required to be completed by a license applicant prior to receiving a fuel-loading and low-power testing license,

(2) those required to be completed by a license applicant prior to receiving a license to operate at appreciable power levels up to full power,

(3) those the NRC will take prior to issuing a fuel-loading and low-power testing or a

full-power operating license, and

(4) those required to be completed by a licensee prior to a specified date.

These actions were chosen by the Commission through a selective process designed to improve the safety of nuclear power plants over a period of time through a sequence of actions. The NRC could reconsider the sequence of these actions and could, for example, move some of the requirements from the category of prerequisites to issuance of operating licenses to the "dated" category.

In the environmental category, the NRC could modify its regulations in 10 C.F.R. Parts 50 and 51 to limit the scope of the environmental review conducted at the operating license stage to those environmentally significant matters that had not been resolved in the environmental review at the construction permit stage. This could result in excluding issues such as the need for the plant, need for power, alternative sites and alternative energy sources from the operating license review stage.

Another way of achieving a similar result would be to modify current NRC procedures for NEPA review which include examination of the need for the plant, need for power, alternative energy sources, and alternative sites. In most cases, these very same examinations are made by

state and Federal agencies before granting a certificate of convenience and necessity for the proposed project under state and Federal utility law. These issues have usually been resolved before the issuance of a construction permit.

In order to avoid further delay at the operating license review stage, Council on Environmental Quality Regulations* and NRC's regulations implementing NEPA ** should be amended to provide a presumption of propriety to state public utility commission and federal agency determinations that a certificate of convenience and necessity be issued. That presumption should be rebuttable only by a showing by a preponderance of evidence that the decision to issue such a certificate was clearly erroneous under applicable law or that it was not based on competent evidence pertaining to the need for the plant, the power it would produce, or the use of alternate fuels and sites.

In addition, the Commission could exclude plants scheduled to receive near-term operating licenses from its recent statement of interim policy calling for consideration

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* 40 C.F.R. 1502.14, 1506.2, 1506.3, 1506.5.

** 10 C.F.R. 51.21, 51.23.(e)

of class 9 accidents in environmental impact statements (45 Fed. Reg. 40101, June 13, 1980).

Other areas of reforming the NRC's current NEPA review might be accomplished without legislation under the existing statutory authority of the NRC. For example, the NRC's decision to exercise its jurisdiction to review and control the construction of off-site, non-safety related facilities such as transmission lines and access roads should be reversed on reconsideraton of its previous interpretation of its NEPA responsibility.*

NRC currently requires a demonstration of financial qualifications for issuance of an operating license pursuant to 10 C.F.R. 50.33(f). The regulations require that if the application is for an operating license, the applicant must demonstrate the availability of the funds necessary to cover estimated operating costs plus the estimated cost of permanently shutting the facility down and maintaining it

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* See, e.g., Public Service Co. of New Hampshire (Seabrook Station, Units 1 and 2), ALAB-422, 6 N.R.C. 33, aff'd sub nom. Public Service Co. of New Hampshire v. NRC, No. 77-1419 (1st Cir. June 21, 1978) (transmission lines); Denial of Petition for Rulemaking," 43 Fed. Reg. 8212 (Feb. 28, 1978), appeal pending, The Detroit Edison Co. v. NRC, No. 78-3187, 6th Cir. 1978 (same); Kansas City Gas and Elec. Co. (Wolf Creek Nuclear Generating Station, Unit No. 1), CLI-77-1, 5 N.R.C. 1 (1977) (access roads).

in a safe condition. The uncertainty of the decommissioning requirements and the potential use of this regulation simply as a means to delay issuing the operating license warrants a relaxation of this requirement.

The hearing process is another area where some immediate reform is possible in the existing procedures applicable to operating license proceedings. The NRC should rigorously enforce rules against late intervention, the raising of insubstantial new issues and relitigation of issues. The basic focus at any operating license hearing should be whether reasonable assurance exists that the construction of the facility has been completed in conformity with the construction permit and the provisions of the Act and rules and regulations of the Commission. With respect to near-term operating licenses, the Commission could provide additional specific guidance to its licensing boards as to those issues that may be litigated (see 45 Fed. Reg. 41738, June 20, 1980). The Commission could also reinstate the immediate effectiveness rule (10 C.F.R. 2.764) or could establish special expedited procedures for near-term operating license proceedings.

Conclusion

It is not the purpose of this memorandum to analyze the savings in time that would result from legislative and regulatory changes along the lines suggested above. If some or all of these changes were adopted, it could reasonably be expected that new completed nuclear power plants could contribute at an earlier date to reducing oil consumption than would be so under the existing regime, without compromising essential objectives of protecting safety, common defense and security and the environment.

ATTACHMENT 4
(Six Pages)

MEMORANDUM WALTER BROWN

TO: Edison Electric Institute September 4, 1980

FROM: Hunton & Williams

Elimination on Emergency Basis of Environmental Constraints Limiting Operation of Power Plants

This memorandum sets forth in somewhat greater detail than our memorandum of August 19, 1980 some of the legislative and regulatory actions that could be taken to enhance supply and manage energy supplies in order to reduce the consumption of oil during the period December 15, 1980 through June 15, 1981 by 1.6 million barrels per day. It discusses actions under the Clean Air Act, Clean Water Act and other environmental statutes as well as the Powerplant and Industrial Fuel Use Act.

Clean Air Act

Regulatory Actions

1. Section 110(f) of the Act, 42 U.S.C. § 7410(f), provides that the Governor of a state, upon a finding that (a) there exists "in the vicinity of" a source in the state a "temporary" energy emergency involving "high levels of unemployment" or "loss of necessary energy supplies" and (b) the temporary unemployment or loss can be partially or totally alleviated by the emergency

suspension of the SIP, may petition the President to declare that a national or regional "energy emergency" exists. If the President declares such an emergency, the Governor may, upon certain conditions, issue a "temporary emergency suspension" of any part of an applicable state implementation plan (including compliance schedules established under § 113(d)) for up to four months.

A SIP suspension under § 110(f) could have the effect of allowing substitution in power plant boilers of higher-sulfur oil, or in a limited number of cases coal, for low sulfur oil. It is unclear whether or not the four months limitation on SIP suspensions under § 110(f) would apply in a continuing emergency. For example, duing the last coal strike some took the position that each day constituted a new emergency.

2. The Administrator of EPA could immediately approve, pursuant to § 110 of the Act, all pending SIP revisions that would authorize increased hours of power plant operation or operation at higher capacity.

Legislative Actions

1. Emergency legislation similar to the authority contained in §.110(f) could be enacted to authorize suspension of SIP provisions in case of a national energy emergency except that (1) the adverse effects of the emergency would not have to occur in the vicinity of the power plant for which the SIP requirements were being waived and (2) the suspension would last as long as the President determined there was an emergency.

The enactment of such legislation would, in appropriate situations, allow increased generation of electricity at coal-fired units by, among other things, allowing de-rated plants to operate at full capacity. This additional capacity would presumably be available for transmission to those areas most affected by an oil cut off.

2. Emergency legislation could be enacted authorizing temporary suspension of applicable NSPS requirements. This would have the effect of permitting by-pass of emissions control equipment required by NSPS and thus increasing available generating capacity.

3. Emergency legislation authorizing temporary suspension of PSD requirements. Same effect as number 2 above.

The above actions do not address otherwise applicable state requirements. Presumably, although the law on this point is not clear particularly where public health and safety are concerned, emergency legislation preempting on a temporary basis, similar state environmental statutes and regulations could be enacted consistent with the 10th Amendment.

Clean Water Act

Regulatory Actions

There are few if any actions which could be taken administratively to eliminate Clean Water Act requirements that reduce otherwise available generating capacity. And those that can be taken would increase that capacity only marginally.

Legislative Actions

1. Emergency legislation that would suspend applicable federal thermal effluent limitations and federally approved state water quality standards. This would allow by-pass of cooling towers, where feasible, and thus increase available generating capacity.

2. Emergency legislation suspending, on a selective basis, effluent limitations and water quality standards that require use of energy intensive control technologies. Like by-pass of cooling towers, this would have the effect of marginally increasing generating capacity that would be available for transmission to areas most affected by the oil cutoff.

The same potential preemption problems discussed above with respect to the Clean Air Act would apply to state water pollution control requirements.

Other Environmental Statutes

1. National Environmental Policy Act

Emergency legislation suspending or postponing applicability of NEPA to major expansions of generating facilities could significantly reduce delay in completion of such expansions. Under EPA's recently promulgated NPDES regulations, any change in a source which results in a change in the nature or quantity of pollutants discharged may result in the source being classified as a new source. Classification of the source as a new source would, under EPA's regulations, subject the source to NEPA requirements including a prohibition on construction until completion of the EIS process.

2. Fish and Wildlife Coordination Act and Other Environmental Requirements Restricting Operation of Hydro Facilities

Emergency legislation suspending environmental restrictions on operation at full capacity of existing hydro-electric facilities. This would have the affect of marginally increasing capacity available for transmission to those areas most affected by an oil cut off.

Power Plant and Industrial Fuel Use Act

Legislative Actions:

1. Emergency legislation authorizing the President to extend on an emergency basis the Temporary Specil Public Interest Exemptions under § 311 which authorize use of natural gas as a boiler fuel in place of oil.

2. Emergency legislation authorizing the President to temporarily suspend § 301(a)(2) and (3) which limit the use of gas as a boiler fuel.

ATTACHMENT 5

NATIONAL ELECTRIC RELIABILITY COUNCIL

ECAR	East Central Area Reliability Coordination Agreement	MAIN	Mid-America Interpool Network	SERC	Southeastern Electric Reliability Council
ERCOT	Electric Reliability Council of Texas	MARCA	Mid-Continent Area Reliability Coordination Agreement	SPP	Southwest Power Pool
MAAC	Mid-Atlantic Area Council	NPCC	Northeast Power Coordinating Council	WSCC	Western Systems Coordinating Council

The National Electric Reliability Council (NERC) was formed in 1968 with the stated purpose "... further to augment the RELIABILITY and ADEQUACY of bulk power supply in the electric utility systems of North America." It consists of nine Regional Reliability Councils and encompasses essentially all of the power systems of the United States and Canadian systems in Ontario, British Columbia, Manitoba, New Brunswick and Alberta.

RELIABILITY and ADEQUACY are two separate but interdependent aspects relating to the bulk power supply system of the electric utility industry in North America. RELIABILITY involves the security of the interconnected transmission network and the avoidance of uncontrolled cascading tripouts which may result in widespread power outages. ADEQUACY refers to having sufficient generating capability to be able at all times to meet the aggregate electric peak loads of all customers and supply all their electric energy requirements.

10/79

TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE 37401
701 Chattanooga Bank Building

January 25, 1983

Hon. Don Fuqua, Chairman
Subcommittee on Energy Development
& Applications
House of Representatives
Washington, D.C. 20515

Hon. Marilyn L. Bouquard, Chairman
Subcommittee on Energy Research
& Development
House of Representatives
Washington, D.C. 20515

Dear Mr. Fuqua and Mrs. Bouquard:

I am pleased to have been able to participate in your hearings on the integrity of electric power systems.

Enclosed are my responses to the questions submitted with your letter of January 6, 1983, and an edited copy of my oral testimony.

Sincerely,

[redacted]
Transmission System Engineering
& Construction

Enclosures

RESPONSE TO QUESTIONS

Question

Would the use of Kevlar jackets around insulators make any sense in protecting transmission systems?

Response

It might be possible to develop a material which is electrically nonconducting and which could deflect gunfire, thus avoiding damage to insulators. However, such a material might change the insulation characteristics of the line or be subject to deterioration from the action of electrical fields and ultraviolet rays.

Research is currently underway to develop nonceramic insulators which are more resistant to damage from gunfire. In either case, protection would be provided against random acts of vandalism, not deliberate acts of sabotage, and the cost might be prohibitive for this small increase in protection.

Question

When restoring power after an outage, regardless of cause, does the TVA have operating procedures which contain priorities that identify who is to get power first, such as hospitals, sanitary facilities, water supply, etc., or does TVA restore power on a technical basis using "islands" and optimum "restart" sequences?

Response

TVA restores power on a technical basis largely because we supply power to 160 municipal and cooperative distributors, who in turn supply the ultimate consumers. Our distributors possess the detailed information on the facilities supplied by various circuits, and they operate by their own procedures which recognize needed priorities for the restoration of power.

Question

Has or is the TVA considering "hardening" electric power facilities by methods such as constructing concrete walls around substations?

Response

TVA continues to look at means of improving the reliability of its power system including hardening some of the electric power facilities and institutes those actions which are felt to be cost effective. TVA has not built nor is it considering at this time building any concrete walls at substations to protect the station against damage by vandals or saboteurs. Since we build all transmission lines overhead, some means of entry by the lines into the substations must be provided. This entry could also be used by those intent on damaging the station. Even if the station is vandal proof, the station could be incapacitated by destroying the lines supplying the station.

Question

You mentioned the extensive tornado damage of 1974 in your written testimony. In a widespread emergency such as this, how does TVA interact with State and local governments and, specifically, what authority does TVA have in determining how power is restored?

Response

TVA has the responsibility of restoring service as quickly as possible after an interruption of service. Essentially, TVA and its distributors of power have complete responsibility and authority to determine how power is restored. We have, in place, a procedure for keeping State and local governments notified and updated through our distributors in situations where there is a power outage.

Question

You mentioned an emergency disaster plan in your written testimony. What government agencies, if any, review that plan and how does it relate to their police and sanitation plans?

Response

TVA has a disaster plan that is distributed to the municipalities and cooperatives we serve. They, in turn, relate this plan to local police and sanitation plans of local governments.

Question

Do you feel an acceleration of the effort toward underground electrical facilities would substantially increase system integrity levels?

Response

Placing of transmission lines underground might remove some of the problems of overhead lines, but the cost at this time would be prohibitive. Underground transmission circuits are still subject to damage and would require much longer time for repairs. Placing transmission facilities underground would protect them from adverse weather damage and random acts of vandalism (gunfire), but not against deliberate acts of sabotage.

Question

What research or technology development could provide for strengthening electric systems in the future?

Response

Additional work in the area of reducing construction costs may make it economical to construct and maintain "redundant lines" so that failure of one line may be minimized by providing additional paths to provide the needed service. Also, more research in the area of insulation could reduce the problem of broken or damaged insulators.

Question

Are the number of incidences over the past ten years involving vandalism, sabotage, or other acts of violence against electric powee production, transmission and distribution systems increasing, decreasing, or remaining constant? Please present statistics if you have them.

Response

We do not have sufficient statistical data to develop a trend involving vandalism, sabotage, or other acts of violence. Our opinion is that these acts are not increasing.

Question

Can you give us a detailed cost comparison between 230-kV overhead and underground transmission construction costs along with comments?

Response

Because TVA does not normally build 230-kV transmission lines in its system and does not have any underground transmission circuits, it would be difficult for us to develop a useful detailed cost comparison. From discussions with other utilities, we understand that for 230-kV lines the cost of a single underground line would be between 5 and 10 times that of a comparable overhead line. Because of the much longer outage periods experienced with underground lines when a fault or damage does occur, a redundant or spare line would probably be necessary, which could make the cost differential even greater.

Question

What future does the TVA see for power transmission using cryogenic-superconducting systems? What impact, if any, would this have on systems vulnerability? Are such cables not better suited to underground transmission than gas-filled cables?

Response

TVA does not foresee that the use of superconducting cables or resistive cryogenic cables would be cost effective on its system. These types of systems are bulk power delivery systems and useful primarily for a high-capacity generating plant to deliver power to a major use point. It is still not a proven system and would require "backup" redundant lines to carry the power if the cryogenic system should become incapacitated. Present research indicates that a high-powered cryogenic cable system would need refrigeration plants about every 5 miles of its length. These also would be subject to vandalism and sabotage. Gas-filled cable systems are more state of the art than cryogenic cables because they more closely match the capacity of overhead lines and have been used for line crossing situations and to avoid other obstructions. Both systems have similar problems because one is gas filled and the other is liquid (nitrogen or helium) filled. The cryogenic system will also have the problem of the necessary refrigeration system.

Question

In reviewing the 1977 New York blackout, the Committee noted what may be an unusual number of equipment malfunctions which aggravated the situation and intensified the problem. Specifically:

1. An inadequately ground transmission line tower in Westchester County;
2. Circuit breakers that failed to reclose after line fault (a loose locking nut resulted in a pressure drop in one circuit breaker and a disconnected closing circuit in another caused the malfunction);

3. An improperly designed circuit breaker opened at Indian Point 3 which disconnected the reactor from its load;
4. An improperly designed timer on the Hudson tieline caused a premature trip;
5. A bent relay contact on a 345-kV line caused the line to trip out on a temporary voltage surge;
6. An antiquated control room design in which confusion results in improper operation; and
7. Equipment undergoing maintenance that was not removed from the "ready list."

Are examples 1 through 7 accurate? Did the September 26, 1977 storm also disclose faulty equipment in the Consolidated Edison system? Is this condition typical; that is, does this level of required corrective actions exist in other utilities? Would it be fair to say these standards of design, workmanship, operation, and maintenance are the result of a generally poor job attitude on the part of working crews? Is it poor supervision? Finally, how does this quality assurance problem impact electric systems vulnerability?

Response

From our review of the published reports of the 1977 New York blackout, the examples cited appear to accurately show the number of unusual equipment

malfunctions which aggravated the situation. A review of the effects of the September 26, 1977 storm in the New York area does indeed disclose that there was also an unusually large number of equipment malfunctions, particularly in power circuit breaker reclosing circuits which failed to restore transmission lines automatically following lightning strokes.

Although there may have been greater-than-normal equipment malfunctions in the two 1977 New York disturbances, some malfunctions can be expected during widespread disturbances involving the operation of a large number of electrical components. In order to provide the degree of reliability and speed of operation which are required of a modern power bulk system under a wide variety of operating conditions, relaying and control circuitry must be complex. The complexity of this circuitry gives rise to the increased possibility of some malfunction. A good program of relay system design and testing should minimize the possibility that this type of failure would contribute to a widespread system disturbance.

We doubt that the standards of design, workmanship, operation, and maintenance are substantially affected by a generally poor job attitude on the part of the working crews. It is our experience that, in general, design application, testing, and maintenance in the electric industry are performed by personnel with sufficient training and experience who have a good attitude toward their job. Proper supervision can help to see that job functions are carried out effectively and can instill a pride of workmanship in designing, testing, and maintaining electrical apparatus.

Improvements in quality assurance programs can reduce the vulnerability of electric systems to widespread outages. Based on our observations, electric utility systems seem to have very good programs to assure reliability. These programs include very tight and exacting equipment specifications including manufacturer's tests, simulated testing of the transmission system under postulated adverse conditions, routine and special equipment test programs, and routine equipment maintenance. By adherence to these programs, the utilities can be assured of a reliable system. It is doubtful that, in most utilities' quality assurance programs, an increase beyond those now being carried would be cost justified. Components of the power system are tested individually, and some system tests are carried out in a simulated manner. Unfortunately, the only way to really test the overall performance of all components simultaneously and the interactions among them is during a system disturbance. Utilities can and do profit by errors and malfunctions that are uncovered during disturbances, and this information is used to improve performance and protect against future vulnerability. The North American Electric Reliability Council has published a series of reports examining and critiquing major electrical system disturbances, as part of the process of making such information available to the industry.

EPRI RESPONSES TO QUESTIONS FOR ROBERT H. IVESON

(Ref: December 9, 1982 Investigative Hearings of Energy Development & Applications/Energy Research & Production Joint Subcommittees on "Integrity of Electric Power Systems")

Bullet 1 - . . progress has EPRI made in developing computer models which analyze the effects of spontaneous oscillations? Will EPRI have sufficient funding to continue this effort in 1983? 1984?

A) EPRI has completed three computer models which analyze the effects of spontaneous oscillations. Their acronyms are AESOPS 1, 2, and 3, standing for Analysis of Essentially Spontaneous Oscillations of Power Systems.

Versions 2 and 3 are extensions of version 1. They provide the ability to analyze larger system configurations with better accuracy and more efficient user features. These programs are receiving good response in the industry and have been used in both the diagnostic (examining an actual event) and the predictive (selecting future settings) modes. Their results have enabled users to modify settings of existing control equipment for more stable operation and select appropriate settings for new facilities as they are integrated into the system.

B & C) Present plans show adequate funding in 1983 and 1984 for work anticipated in analysis of spontaneous oscillations.

Bullet 2 - Would the use of DC links, particularly in the West, make those transmission systems less vulnerable to spontaneous oscillations?

This would be dependent on the character of the "DC links". Two DC links can be predicated. The first would be comparable with the present 800 mile DC link between Oregon and southern California.

It is generally acknowledged that its ability to transmit on the order of 1400 MW in either direction in conjunction with its companion 500 KV AC circuits results in a system less susceptible to oscillation, i.e., an electrically tighter knit system. Similar long distance DC links between generation and load centers on the 4000 mile western "doughnut" would undoubtedly reduce its vulnerability to spontaneous oscillations.

The second type of "DC links" could be back-to-back converter stations located at points in the western "doughnut". These would, in essence, sectionalize the loop into segments not connected in electrical synchronism. In theory at least, this should minimize the potential for spontaneous oscillation. With the relative newness of large scale DC connections, such a configuration has never been designed, built, and operated, and the complexity of DC control circuits connected in a ring configuration might well produce reactions not foreseen in any current modeling capability.

In either case, with the high cost of DC facilities, a careful economic assessment would be required to assure that DC links were the technical and economic preference for resolving a spontaneous oscillation problem, should it exist.

Bullet 3 - Would the shielding of critical devices, such as distribution transformers with kevlar enclosures, serve to make these systems less vulnerable to rifle bullets? Has EPRI considered such materials?

EPRI has not considered such materials. Several components such as bushings make these devices candidates for damage. Experience

to date indicates that rifle damage is not a serious problem for distribution equipment.

Bullet 4 - Are there any monitoring and communications equipment which can be read in a distribution control room that compare the rotor angle of primary generators in the system? Should there be?

Yes, such equipment is available and it serves a useful function in monitoring certain dynamic characteristics of system security.

Bullet 5 - Relative to physical security, what proximity detection devices might be employed around transmission towers to lessen the placement of explosive charges and could such devices communicate to distribution control by multiplexing?

There are about 2 million transmission towers in this country. Protecting them with warning (proximity) devices would not be effective regardless of the expenditure made. Since most towers are fully accessible to the public, a large number of false alarms would be expected, thus obviating the value of this approach.

Bullet 6 - What effect does the trend toward the large, 1,000 + MW generating plants have on overall systems vulnerability?

Present-day analysis of generation reliability shows that large 1000 + MW generators combined with their actual forced outage rates (which are somewhat higher than small units) result in a degradation of the index of service reliability when compared with smaller units and their associated lower forced outage rates. That is, for the same system configuration and total MW generation, a system with 1000 + MW generators and higher forced outage rates will require a higher installed reserve than a system with smaller generators and lower forced outage rates to achieve the same index of service reliability.

The most important point to recognize is that <u>both</u> the generator size <u>and</u> forced outage rate are significant to system reliability. The best

configuration is that of large units to achieve economy of scale and low forced outage rates to provide high availability of the unit. EPRI has sustained a considerable effort in this area in both the fossil fired and nuclear generation Divisions to improve the availability and reduce forced outage rates.

Bullet 7 - Regarding organized sabotage by well-trained teams, what is your opinion about how physical security can be enhanced?

This question is outside my area of competence and that of other researchers at EPRI. We would be happy to cooperate with military or security experts to answer the question in the utility context.

Bullet 8 - The December 5 Washington Post contained a lengthy article on the dangers of electro-magnetic-pulse (EMP) conditions. The article specifically mentioned that a surge of EMP "would trip circuit breakers throughout the power grid." What research has been done, what controlled experiments have been conducted and what has been learned about the effects of EMP conditions on electric systems and how to mitigate them?

No work has been sponsored by EPRI in this area.

It is our understanding that there is a large body of research carried on by the military and the communications industry, much of which requires high security clearance for access. Members of EPRI senior management have received such clearances so as to maintain an awareness of current research activities.

The most recent publicly identified effort is by DOE with Oak Ridge National Laboratories as reported by Mr. Vaughn in the December 9 hearings.

Bullet 9 - What research is EPRI presently conducting which will make electric systems less vulnerable?

This question is of a generic nature and requires a definition of "less vulnerable" to what. For example, it can be assumed to mean less vulnerable to traditional mechanisms of failure such as natural wear and tear, and thermal and electrical stress. Under this definition, a considerable amount of EPRI effort is directed toward extending the life of existing equipment and use of materials and procedures which will produce longer lasting, high availability, low maintenance equipment. Examples in the Electrical Systems Division are the work of the Distribution, Overhead and Underground Transmission and Substation Programs. Similar examples exist in the Nuclear and Coal Combustion Systems Divisions.

If "less vulnerable" is defined as to hostile, terrorist, or malicious acts, then the research effort at EPRI is not directed toward these areas specifically. Less vulnerability would only result from good engineering design and application.

Bullet 10 - What research does EPRI plan to do to strengthen electric power systems?

The answer to this question is similar to that of Bullet 9 with a similar qualification that "strengthen" relates to factors other than hostile or terrorist acts. EPRI's current 5 year plan (1982-1986) shows extensive efforts planned in both individual component research and in systems effort. Examples in the PSPO program specifically are: RP1712, Static Security Analysis Programs, which will provide an improved on-line security evaluation capability and RP1530, a

program for assessing overall power system reliability including the effects of transmission.

Bullet 11 - What additional research do you think the federal government should undertake, if any, in high voltage DC transmission, superconducting storage, DC to AC conversion, EMP or any other appropriate area?

As noted in my December 9 testimony, regulatory pressure to demonstrate immediate results of research expenditures has caused EPRI to focus its efforts toward "near term research". This results in very limited funding for the high risk research projects which, if successful, might produce substantial benefits. In that context, therefore, the Federal government might undertake research in high risk research. Although EPRI would not attempt to set the federal R&D agenda, the areas mentioned are legitimate fields for further research, either to improve present technology, prove or disprove economic feasibility, or address national security concerns.

In addition, responses contained elsewhere in this set of questions advocate federal support in several areas not mentioned above.

Bullet 12 - In your written testimony, you mentioned that control systems are expensive, costly to maintain and subject to misoperation. Do you have any concepts or ideas where specific research might result in advancing the state of the art?

Research in this area should be pursued in three major directions:

1. Reduce the hardware cost and installation cost of monitoring and control equipment
2. Improve reliability of monitoring and control equipment
3. Improve speed and accuracy of analytic methods (usually computer programs) and corrective action analysis capability

In some ways 1 and 3 overlap as follows. Control systems depend upon data on system flows, voltages, and other parameters in order to detect system abnormalities and maintain operating conditions within acceptable ranges. These system data may be obtained either by (1) direct measurement of large amounts of data and transmission to a control center or (2) by use of computer programs and a limited number of measurements by which a complete set of system readings may be calculated (This is called state estimation). A choice thus exists between improving the hardware and communication links or improving the ability to provide increasingly accurate state estimating capabilities. A balanced research program would support efforts in both areas.

Some specific examples of areas where cost reduction could occur are: present voltage transducers (PT's) and current transducers (CT's) for high voltage measurements are cumbersome, expensive, and prone to failure. A typical PT/CT installation at 345 KV for a single circuit can cost up to $100,000. A simple, inexpensive maintenance-free voltage and current transducer combined with an inexpensive and secure communication

system is needed and would provide the necessary data for economic, reliable control systems.

In a similar vein, present day algorithms and computational capabilities for large scale state estimation are both imprecise and slow. Research is needed in both the algorithm and computer structures best suited for these requirements.

In the area of reliability of control systems, work is needed to describe the structure of these systems, analyze the failure modes of both components and systems, and determine where the greatest need for research to improve reliability exists. For example, is more redundancy required with existing components or less redundancy with higher reliability components.

The above are only examples. There are a number of areas in which better analytic capabilities are required.

Bullet 13 - Is more fundamental research necessary to speed the transition to underground electrical facilities?

The question implies that there is a need to speed the transition to underground facilities. That, of course, is a subjective premise. There are some real practical benefits of overhead or above ground construction. The first will continue to be cost; others are rapid location and repair of failed equipment.

However, recognizing that there are circumstances in which underground

facilities are the preferred installation, there are areas in which more fundamental research is necessary. Examples are basic materials research and superconducting properties.

Bullet 14 - Have state regulatory agencies typically been sympathetic to utility expenditures in areas primarily intended to increase system integrity?

Recognizing the diversity of state regulatory agencies and their numerous actions, a blanket yes or no answer is not possible. In many instances, the Commissions have been responsive to the utilities needs to maintain adequate levels of system integrity.

However, there is concern in some regions of the country that regulatory processes have delayed the installation of generation and transmission facilities and that system integrity is or will be effected. These have been identified in the most recent review of system reliability by the North American Electric Reliability Council (NERC), entitled 12th Annual Review of Overall Reliability and Adequacy of the North American Bulk Power Systems, August 1982. Mr. Gent spoke to an example of this in the Baltimore/Washington area in his testimony on December 9.

Unfortunately, there is no reward to the utility for "the interruption that did not occur". A possible strategy for rewarding good service might be analogous to recent techniques involving plant performance. Several states have established a dual standard where performance above a certain level in a plant is rewarded with permission to earn slightly higher earnings. Conversely, performance below a certain level is penalized with reduced earnings. A similar

strategy based on a standard acceptable interruption level with reward/penalties above and below that standard would provide an economic incentive for maintaining a given level of reliability. Each utility could establish its acceptable interruption level based on the past performance and individual service requirements.

Bullet 15 - What is EPRI's position on 6-phase power for increasing transmission capacities?

EPRI has followed research carried on by both DOE and individual utilities in multi-phase (greater than 3) power. Our most recent effort is in RP1764-5, Fault Protection for High Phase Order Transmission Lines. Our position is to provide the necessary analytical tools by which a utility may assess 6-phase transmission as an alternate to more traditional facilities.

Bullet 16 - What is EPRI's opinion of the potential effects of automated power distribution on systems vulnerability?

Microprocessor and communication technology has progressed to the point that capabilities may soon be available to provide control over increments of interruptible load to maintain system security under normal operating conditions and during system disturbances. Distribution system reliability would be enhanced.

Bullet 17 - What progress has EPRI made in its work on "power conditioning systems" (PSC) to facilitate the incorporation of dispersed power systems? What problems remain to be solved for small (10-30 KW) systems?

EPRI's efforts on PCS have been focused primarily in the 1 to 10 MW range.

Three major projects consisting of a 3.5 MW unit in Montana, a 2.5 MW unit in New Jersey, and a 4.8 MW unit in New York City progressed significantly in 1982. The first became operational in early 1982 and is under test. The second became fully operational in July 1982, and the third became operational in early 1983 and is also under test.

EPRI has not carried on any work in the small (10-30 KW) range. DOE has carried on a substantial effort in that area. We suggest that the question be referred to DOE.

Bullet 18 - Does EPRI envision a forthcoming greater role for DC transmission over AC transmission? What are your comments?

DC will continue to serve a role in specific applications where its specific technical advantages outweigh its higher cost and the greater technical complexity of converter stations. Examples of possible applications are long distance (over 40 miles) underground cables; long distance (over 300 miles) overhead transmission to connect large generation complexes to an existing grid; and coupling two systems asynchronously where there are either no existing ties or very weak ties.

In more general applications, however, a "greater role" is not foreseen until there are economic advantages over comparable AC facilities.

Bullet 19 - What additional fuel cell research is needed and how should the federal government participate in it? How can the use of fuel cells reduce vulnerability? What size modules would be most effective?

Question 1 - What additional fuel cell research is needed and how should the federal government participate in it?

The immediate private sector thrust is the commercialization of the phosphoric acid fuel cell power plants. Longer term technologies being investigated are advanced acid, molten carbonate and solid oxide systems. Utility industry studies show that phosphoric acid fuel cell systems could find substantial application in the early 1990's with significant societal benefits including reduced pollution, higher fuel efficiency, lower revenue requirements. If American industry is to capitalize on this future market, the technology needed to spur U.S. manufacturers to produce fuel cell power plants must be developed and verified within the next few years.

Current phosphoric acid technology programs sponsored by DOE, individual utilities, Gas Research Institute, EPRI, and others are attempting to develop the technology base to expedite the commercial activity. Continued DOE participation in these programs is the key to their overall success as the DOE contribution (funding) is virtually irreplaceable.

The other three technology areas mentioned, i.e., advanced acid, molten carbonate and solid oxide, are longer term but hold the potential for much higher efficiencies and higher temperature operation providing for increased potential use in cogeneration.

DOE's current and planned work on phosphoric acid systems should be

given the highest priority with advanced acid, molten carbonate and solid oxide receiving enough funding to continue basic investigations. FY '82 and '83 DOE funding levels ($34 and $32 million, respectively) were just adequate for the activities conducted in those years. Increased activity in 1984 and 1985 as the current fuel cell programs come into full swing suggest an annual DOE funding level of $25 to $30 million for phosphoric acid work and $11 million for the other technologies.

Question 2 - How can the use of fuel cells reduce vulnerability?

First, fuel cells are expected to have higher reliability and availability than conventional generating units.

Second, fuel cells as dispersed generators sited in small blocks near load centers will reduce loading on vulnerable transmission circuits and present a potentially large number of "targets", loss of any one which would probably not present a major power outage or system instability. As a result, the reliability of the utility system could be improved.

Question 3 - What size modules would be most effective?

Commercial units will initially be about 10MW due to economies of scale and auxiliary equipment sizes. As utilities utilize fuel cell power plants, other sizes may become available to meet specific needs.

Bullet 20 - In reviewing the 1977 New York blackout, the Committee noted what may be an unusual number of equipment malfunctions which aggravated the situation and intensified the problem. Specifically:

1. An inadequately grounded transmission line tower in Westchester County;

2. Circuit breakers that failed to reclose after line fault (a loose locking nut resulted in a pressure drop in one circuit breaker and a disconnected closing circuit in another caused the malfunction);

3. An improperly designed circuit breaker opened at Indian Point 3 which disconnected the reactor from its load;

4. An improperly designed timer on the Hudson tie line caused a premature trip;

5. A bent relay contact on a 345 kv line caused the line to trip out on a temporary voltage surge;

6. An antiquated control room design in which confusion resulted in improper operation; and

7. Equipment undergoing maintenance that was not removed from the "ready list".

Are examples 1 through 7 accurate?

The information contained in this questions is very system specific and not subject to clear verification without a substantial effort involving the utility (ies) involved.

Did the September 26, 1977 storm also disclose faulty equipment in the Consolidated Edison system?

The interruption referred to occurred in a July 13,1977 storm. We are unaware of an interruption involving a September 26, 1977 storm.

Is this condition typical; that is, does this level of required corrective actions exist in other utilities? Would it be fair to say these standards of design, workmanship, operation and maintenance are the results of a generally poor job attitude on the part of the working crews? Is it poor supervision? Finally, how does this quality assurance problem impact electric system vulnerability?

Responses to these questions would require a detailed study and analysis of the utility involved. A generalized response would be inappropriate.